Chapter 2
THEORETICAL AND LEGAL SUPPORT OF CRIMINALISTIC RESEARCH OF CARTRIDGES (AMMUNITION) TO MANUAL SMALL ARMS

2.1. Cartridges (ammunition) as objects criminalistic research (concept, essence, classification)

Currently, one of the unresolved problems of assessing the conclusion of forensic ballistic examination is the use in its content of terms and their definitions that do not meet modern scientific ideas about the objects under study. This applies to both legislative acts and normative legal acts regulating the conduct of relevant examinations, in particular the study of cartridges (ammunition) used for shooting from small arms, traces of their use. However, the accuracy and unambiguity of terminology used in forensic ballistic examination of cartridges (ammunition) are important to ensure its uniform understanding and use in both forensic and law enforcement activities.

It is no coincidence that the literature emphasizes that one of the main elements of the concept of the General theory of forensic examination is the doctrine of the means and forms of communicative activity in the production of forensic examinations; the Central part of this element is the language of the expert, the system of expert concepts and terms designating them. The development and improvement of the General theory of forensic examination largely depend on the development and improvement of its conceptual apparatus, in-depth disclosure of the essence of objects, phenomena reflected in each concept [3, p. 103].

R. S. Belkin notes that the introduction of new terms and their definitions into forensic examination as a specific sphere of scientific knowledge is carried out by expanding the existing basis of theoretical provisions and empirical data [36, p. 98].

Analysis of the relevant legal framework of the Republic of Belarus indicates that the Criminal code of the Republic of Belarus (hereinafter-the criminal code) [266] does not contain definitions of the terms “weapon”, “firearm”, “cartridge”, “ammunition”. Judicial practice is focused on a special normative legal act-the Law of the Republic of Belarus of November 13, 2001 No. 61-Z “on weapons” (hereinafter — the law

“On Weapons”) [181]. Paragraph 3 of the resolution of Plenum of the Supreme Court of the Republic of Belarus of April 3, 2008 No. 1 “On Judicial Practice on Cases on Crimes Related to Illegal Actions Against Weapons, Ammunition and Explosives (articles 294–297 of the code)” [192] contains a directed courts to apply in its activities the terms and their definitions contained in article 1 of the Law “On Weapons”. Thus, the relevant gap in the criminal law has been filled by extending the provisions of the said law regulating the administrative and legal regime of legal arms trafficking to the sphere of criminal law regulation.

This approach needs more detailed analysis. It should be borne in mind that the definitions of terms contained In the law “on weapons” are intended only to facilitate the understanding of the content of the provisions of this normative legal act. These definitions, although they reflect some technical characteristics inherent in various types of weapons, ammunition, etc., are not technical, but have a legal nature of origin and application.

In the legal literature, attention is drawn, in particular by Yu. G. Korukhov, to the fact that in the practical activities of law enforcement agencies, due to the imperfection of designs and textual forms of law, certain difficulties arise in the perception of their content. The legal norm can cover any volume of public relations which are amenable to legal regulation. At the same time, such regulation can be effective only if the methods of regulation correspond to the nature and characteristics of public relations. The problem of perception of law is always mediated by its textual form and appears in the classical form as a problem of legal interpretation [108].

With regard to forensic ballistics, M. A. Sonis notes that the lack of uniformity in the definition of the concepts of “cartridge” and” ammunition” in various fields of knowledge is due to the many approaches to which this scientist refers to the following: the use of the forensic concept of cartridges (ammunition); use of the terms and their definitions contained in legislative and other regulatory legal acts; use of the terms given in the state standards and technical conditions concerning production, storage and use of the specified objects [237].

According to M. A. Sonis, the existence of a problem in law, which can be defined as the regulation of public relations, can not serve as a basis for changing the existing existing provisions, concepts used in various fields of society: technology, military science, etc. [237].

In our opinion, the objective essence of physical phenomena and processes cannot be expressed by a legal definition only using legal approaches, otherwise such a definition will inevitably have a limited character. Natural-scientific regularities exist regardless of society and relations within it. Prescriptions of norms of the law reflecting in the textual form technical, physical and other signs of the phenomena of the nature, should identically reflect their essence and be perceived by the law enforcement agent according to their actual sense in order to avoid double understanding and discrepancies.

These defects of legal regulation complicate the possibility of qualitative assessment of the content of the expert's opinion, and hence the proper assessment of the degree of its reliability, since it is the correspondence of terms and their definitions to the current level of scientific knowledge that allows you to select a particular object of forensic ballistic research from a set of objects similar to it in certain properties and qualities [225; 226].

Expert practice has formed the following approach to the solution of the problem under consideration: when conducting forensic ballistic examinations of cartridges (ammunition) used for shooting from small arms, the terms and their definitions used in the process of its industrial standardization should be applied. This requirement is expressly provided in the relevant methods of research of objects of such examinations [163; 166].

The specified requirement is directed on simplification of perception and an assessment by authorized subjects of proof and other persons of such difficult source of proofs, as the conclusion of judicial-ballistic examination. The use of different approaches to the definition of the terms used in it and their definitions both at the theoretical level (in criminology and other Sciences) and in normative legal acts, state standards and other documents leads to ambiguity of opinions arising during forensic ballistic examination, regarding the attribution of small arms cartridges to the category of ammunition.

Until recently, the theory of forensic examination was dominated by the view that, in relation to the conduct of forensic examination, special knowledge is that which is outside the framework of legal provisions, well-known generalizations arising from life experience [78; 214].

However, now many scientists and practitioners this position is questioned. Thus, A. S. Podshibyakin believes that at the present stage of development of law, judicial experts not only can, but also must take into account, for example, the provisions of national and international legislation and take them as a basis for solving their tasks. In this regard, in relation to Russian practice, the author points out that forensic experts should be guided by both traditional provisions of criminology (in particular, relating to the classification and characteristics of weapons) and the content of the laws of the Russian Federation and international law [208]. I. V. Latyshov notes that the starting point in the field of expert research of small arms, ammunition, traces of their use should be considered a set of terms enshrined in the normative legal acts regulating the circulation of weapons, industry terms and their definitions of forensic ballistics, Military and Technical Sciences [147, p. 8–13].

In the forensic literature as an example of application in forensic activity of the legal knowledge reflected in provisions of normative legal acts, the decision of classification tasks at carrying out forensic ballistic examinations of manual small arms, cartridges (ammunition) used for firing from it, etc.

Thus, it is implied that in the process of conducting these examinations, the expert identifies the necessary set of features of the objects under study, which correlate with the features enshrined in the relevant legal definitions contained in the texts of normative legal acts establishing the state-legal regime of circulation of small arms and ammunition (ammunition) to it [91].

The close connection of forensic ballistic examination with the state legal regulation of the turnover of cartridges (ammunition) used for shooting from small arms is that the conclusion of forensic ballistic examination is the only source of information about technical characteristics (features), information about which is formally unavailable for perception by other subjects of law enforcement activity in the process of resolving a criminal case on the merits.

Proceeding from the theoretical position on the unity of forensic technology and the principle of legality, the technical competence of the employee of the body of inquiry, the investigator, the Prosecutor can not be formally limited; in this regard, such persons are subject to the only requirement: the material evidence, subjected to research by scientific and technical methods, should not be destroyed or changed; in each concrete period there is a certain objective boundary of possibilities of use of scientific and technical methods and means of research of material proofs by the employee of body of inquiry, the investigator, the Prosecutor and the expert [212, pp. 267–269].

This conclusion is based on the fact that the cartridges (ammunition) used for shooting from small arms are specific objects of the material world, the study of which requires special knowledge and the necessary technical means. Some scientists note that the study in the form of expertise involves obtaining such new factual data that were not known to the law enforcement officer and that can not be obtained in other ways, in connection with which the purpose of a special study of forensic objects is not only to ascertain the new facts of objective reality established by the expert, but also in their special, professional assessment [91].

However, as already mentioned, based on the General provisions of the theory of forensic examination, the expert bases his conclusions solely on existing scientific ideas, provisions of technical regulations and methods of forensic research of objects of forensic ballistic examination. On the basis of special knowledge in the relevant field of science, technology, art or craft when conducting research and solving the expert task, the expert establishes and evaluates the compliance of the necessary and sufficient set of signs of the object under study with the complex of signs inherent in hand-held small arms, cartridges (ammunition) used for firing from it, and then sets them out in the form of conclusions. In the research part of the expert's conclusion, other essential features of the object under study are also indicated, which allow to qualitatively determine its properties. In this regard, it is advisable to support the point of view of T. V. Averyanova, according to which in such cases there is an establishment of the technical and not the legal side of the phenomenon under study, since the conclusion obtained in the course of the examination does not prejudge the General conclusion about the guilt of the person [3, pp. 189–190].

It should be emphasized that the approach to the definition of the concept of "cartridge" in criminology, military and technical Sciences after the transition in the early XX century. to the use of hand firearms unitary cartridge to date has not undergone any significant changes. In encyclopedic and special literature contain the next definitions patron: "compound in one thing whole bullets, gunpowder weapons and the capsule " [39, p. 319]; "a firearm munition in which a bullet, a propellant and a means of ignition are combined into one whole by a sleeve"

[40, p. 279]; "a small arms munition, which is an Assembly unit consisting in General of a propellant element, a propellant charge, an igniter capsule and a sleeve" [190, p. 35] etc.

Similar definitions of a unitary cartridge provides Russian researchers A. G. Egorov, A. V. Stalmakov, A. M. Sumaroka and A. G. Sukharev, "Chuck, where by the casings are connected together bullet, powder charge and primer-igniter" [248, p. 43], I. V. Gorbachev and A. V. Mileva, "Chuck, all elements of which are United by the sleeve" [112, p. 42; 167, pp. 78–79], as well as Belarusian scientist A. V. Dulov: "a device in which the charge the bullet and the primer-igniter cartridge combined into a single entity" [65, p. 211], etc. Reflected in the theoretical sources of the General characteristics of the cartridge as a constituent element of the weapons complex and the object of forensic research, the essence of which is to combine as a single device propellant charge, propellant element and primer-igniter (initiation device) through the sleeve, reproduced in the legislation. So, in paragraph 13 of part 1 of article 1 of The law "On Arms" the following definition is fixed "the cartridge-ammunition in which the thrown element, the throwing charge and means of initiation are United in one whole by means of a sleeve" [181].

The word "munition" in the definition of "cartridge", used in the military and technical Sciences, appeared after the Second world war as a result of theoretical developments in the field of weapons, the effectiveness of which is constantly improved. The result of theoretical research was the introduction of a new term "complex weapons", denoting a set of samples of military equipment, functionally related and used to solve combat problems. At the same time, attention is drawn to the fact that the mandatory element of the weapons complex is the weapon together with the means of destruction (ammunition), directly intended to defeat the target [241, pp. 19–20].

In legal science, the term "ammunition" is associated with its introduction into the criminal code of the RSFSR in 1960, since the criminal codes of the RSFSR in 1922 (article 220) and 1926 (article 182) it was exclusively about firearms. Resolution VTSIK and SNK RSFSR from 20 March 1933 "About climate article 182 Criminal Code" in quoted article was introduced addition, in a result what part of the first formulated the next way:" the Fabrication, storage, purchase and sale explosives substances or projectiles, and would still firearms (except hunting smoothbore) weapons without proper resolution…". Since the term "shells" did not reflect the essence of the term and allowed ambiguous understanding, the Criminal Code of the RSFSR in 1960 and the Union republics introduced the term" ammunition" [6, p. 20].

In the Law "On Weapons" and the state standard of the USSR 28653-90 "Small Arms. Terms and Definitions" (hereinafter-GOST) [190, p. 35] contains terms and their definitions relating to the objects of factory production: manual small arms and ammunition manufactured by industrial enterprises. Issues relating to ammunition (ammo) improvised, and improvised firearms that are the subject of forensic investigation, the Law "On Weapons" and the GOST is not regulated, because such objects, though made in the likeness of industrial designs (fully or partially) or their components (parts), do not meet the technical requirements of industrial production.

In the first part of article 1 Of the law "On Weapons" the legislator establishes legal terms and their definitions used in law enforcement practice. Such norms-definitions as a General rule are designed to facilitate the understanding of the essence of the provisions of the normative legal act by the subjects of law enforcement and perform "heuristic, guiding and orienting functions in the mechanism of legal regulation of the relevant sphere of legal relations" [254, p. 406]. As a result of understanding the meaning of the term the law enforcement officer is able to correctly interpret the provisions of the normative legal act containing it. This facilitates the perception by this subject of the meaning of the norms, the wording of which includes complex specialized, including some technical terms included in the legal construction of the provisions of the relevant regulatory legal act (in this case — The law "On Weapons"), characterizing such objects of the material world as hand-held small arms, ammunition (ammunition) used for firing from it.

The use of special terminology borrowed from technical and military literature (manuals, standards, specifications, etc.), is only auxiliaryAt the same time, the text of the expert's opinion may contain references to the provisions of technical normative legal acts, which will facilitate the assessment of the reliability of the substantive part of the forensic ballistic examination conclusion and thus have a positive impact on law enforcement practice. A similar position is held by Russian scientists, who believe that the terms used in forensic ballistics and their definitions require unification, since only in this case it is possible to achieve unambiguity of terminology [95, pp. 36–37].

In the legislation of the Republic of Belarus the problem of unification of terms and their definitions established in article 1 Of the law "On Weapons" with the terms and their definitions contained in the methods of research of various types of weapons, in technical normative legal acts defining mandatory *technical* requirements for weapons, the processes of its development, production, operation (use), storage, transportation, sale and disposal remains unsolved.

Certain terms and their definitions provided for by the provisions Of the law "On Weapons" are characterized by uncertainty, and therefore need to be adjusted.

The analysis of the terms and their definitions enshrined In the law "On Weapons" shows that article 1 of this law is of a regulatory and technical nature, since the definitions of terms contained in it are based on the technical characteristics inherent in these objects. In order to facilitate the law enforcement perception of the provisions of this law, the legislator is forced to use technical features in it. At the same time, it should be emphasized that the Law "On Weapons", which establishes the legal regime of turnover of hand-held firearms, cartridges (ammunition) used for firing from it, does not define the technical features of the device of these objects, but regulates public relations related to the right of possession, use and disposal by authorized entities of certain types of hand-held firearms, cartridges (ammunition) to it. As already emphasized, only an expert, based on the relevant knowledge in forensic ballistics and information from related Sciences, has the right to establish the technical characteristics and design features of such specific objects of research as hand-held firearms, cartridges (ammunition) used for firing from it, in turn, the exclusive prerogative of the law enforcement officer is to assess the content of the conclusions obtained in the process of forensic ballistic examination.

The presence of legal uncertainty is characteristic, in particular, for part two of article 6 and part two of article 7 Of the law "On Weapons", the norms of which prohibit the use in service and civilian weapons cartridges (ammunition) "with cores of solid materials" [181], but the hardness criteria for the materials of the cores of bullets in this law are not established, which may lead to different understanding and different application of these norms in practice.

It should be noted that some terms and their definitions contained in article 1 of The law "On Weapons" are not fully consistent with the provisions of technical regulations governing issues related to the technical regulation and standardization of small arms, ammunition (ammunition) used in it for shooting, as well as insufficiently take into account modern scientific ideas about these objects of expert research. In particular, the definition of the term “ammunition” given in the said law fully reproduces the definition enshrined in the relevant technical normative legal act intended for use in military science, military technology and military production. This definition does not fully reflect the properties of objects for the regulation of the turnover of Which the law “On Weapons” is intended, since, for example, cartridges (ammunition) for smoothbore hunting firearms, homemade, reloaded cartridges are not products of military production [108].

In addition to the differences in terms and their definitions used in the military, technical, forensic fields of knowledge, this discrepancy is due to the fact that in the process of knowledge, a person distinguishes in the surrounding objects the General, essential, specific, natural, distracting from the accidental and secondary, resorting to simplifications and schematization. From the philosophical point of view, such simplified, schematic objects are introduced by means of definitions, making it unnecessary in each case to reduce the complex (complex concepts and objects) to the elementary (to the concepts and objects of the original basis of the theory). At the same time, the definitions are limited, that is, do not reflect the entire content of the studied subject (phenomenon), which is described by the relevant branch of science [277, p. 152].

With regard to the formulation of definitions of terms used in the production of forensic ballistic examinations, E. N. Tikhonov considers it necessary to be guided by a number of principles: 1) the terms used and their definitions must comply with the laws of formal logic; 2) the basic (initial) should be the concepts developed in military-technical and other Sciences (at the same time such terms should be rethought and, in accordance with the objectives of forensic science, make appropriate changes and clarifications); 3) in the course of the formation of the conceptual apparatus used in the production of forensic ballistic examinations, special attention is required to the concepts contained in criminal law [259, pp. 16–17]. A similar opinion is held by T. V. Averyanova, who believes that, along with the knowledge of the General scientific nature of the terms, it is no less important to concretize the concepts that are designated by these terms, especially in the case when the term borrowed by one area of knowledge (in particular, forensic expertise) from another, has a different meaning [3, p. 109].

Special knowledge used in the production of forensic ballistic examinations of cartridges (ammunition), based on the laws of the development of scientific ideas and technical improvement of these objects of study. Unification of terms and their definitions used during forensic ballistic examination of cartridges (ammunition) used for shooting from small arms, specification of provisions of normative legal acts contribute to ensuring their unambiguous perception and uniform application in law enforcement practice, in particular, allow to increase the reliability of the expert's opinion, to ensure the possibility of its evaluation by persons conducting an inquiry, investigators, prosecutors and judges.

This circumstance is important for the sphere of expert research, since the content of the expert's opinion must meet, among other things, the requirements of scientific validity and credibility, accuracy and scientific determinism. If an expert violates these requirements, such a study cannot be a priori recognized as qualitative, objective and reliable [226]. In addition, the unification of terms and their definitions is one of the fundamental trends in the development of the language of science: the number of terms denoting the same object is reduced; several existing terms are replaced by one new term, which does not appear alongside the old ones, but instead of them [301, p. 118].

It should be noted that norm-setting activities should be observed flowing from the Constitution of the Republic of Belarus of the rule of law (article 7) [105] the principle of legal certainty that suggests the clarity, accuracy, consistency, logical coherence of provisions of normative legal acts. This pre-empts their ambiguous understanding and, consequently, improper application, creates conditions for uniformity and predictability of law enforcement practice [191].

As mentioned earlier, the conceptual and categorical apparatus, reflecting the technical characteristics and requirements for cartridges (ammunition) of industrial manufacture, mandatory for the production and operation of these facilities, is not contained in The law "On Weapons", but in the relevant technical regulations. According to the Law of the Republic of Belarus of January 5, 2004 "On Technical Regulation and Standardization", the norms of this law and technical regulations regulate relations (note that this does not indicate the public nature of relations) arising in the development, approval and application of technical requirements for products, processes of its development, production, operation (use), storage, transportation, sale and disposal [193].

In practice forensic-ballistic research patrons (ammunition) should be guided by term “munition”, developed forensic science, because aside from patrons (ammunition) factory assemble this the notion of should encompass also similar on device and principle actions fully homemade and peresnaryazhennye patrons (ammunition).

Currently, in the literature on forensic ballistics and forensic medicine, the most commonly used definition is: “ammunition is a multi-component in its design, disposable items designed to hit a target using explosives as a result of a firearm shot or explosion” [211, p. 35; 248, p. 42]. In accordance with the fourth paragraph of section 1 Methods of forensic investigation of firearms traumatic ammunition related devices and objects designed specifically for hitting the target, performing tasks, contributing to its defeat and containing explosive, pyrotechnic or propellant, or a combination [161].

Thus, in the given provision the definition of the term “ammunition” fixed in article 1 of The law “On Weapons” is literally reproduced”. The use of this definition in the text of the mentioned methodology is not fully justified, since it does not reflect the concept in question from the point of view of forensic ballistics. In this regard, in relation to the forensic ballistic examination of cartridges (ammunition) used for firing small arms, it is advisable to develop a narrower definition of the term “ammunition” in relation to these types of objects of expert research.

In paragraph 26 of section 3 of the previously valid in the Republic of Belarus Methods of forensic examination of cartridges of small arms, their serviceability and suitability for use for the intended purpose (hereinafter — the method of forensic examination of cartridges) fixed the following definition of the term in question: ammunition (from the point of view of forensic ballistics) is a multicomponent in its design, disposable items designed for mechanical destruction of the target at a distance by a projectile thrown with the energy of powder gases or other explosive substance as a result of a shot from a firearm [163].

In Russian scientific literature (particularly in the work of D. A. Storms) ammunition used for shooting from manual small firearms, defined as “disposable, multi-piece item is designed for target projectile as the result of a shot in the corresponding sample handguns” [31, p. 66].

These definitions also do not fully meet the goals and objectives of forensic ballistic examination. As noted by M. A. Sonis, analysis of the definitions of "ammunition" and "Chuck" suggests that the concept of "ammunition" in forensic science reflect the purpose of items, in contrast to the term "cartridge" which defines only the product design, in connection with the issue of ammunition should be used as knowledge in engineering and military science to uncover the nature of these concepts [237].

Currently, in military and forensic science, a sample of hand-held small arms with a cartridge used for firing from it is considered as an integral complex "weapon-cartridge", the elements of which interact with each other in the process of functioning. The effectiveness of this complex in the process defeats the purpose almost entirely determined by the cartridge [32, p. 7]. Thus, in the specified context of the "weapon — cartridge" system, we are talking about a sample of firearms manufactured for a specific sample of the cartridge. In turn, the cartridge as an integral part of the "munition — weapon — target" system is considered as a munition, that is, a device designed to defeat the target as a result of firing. From the point of view of forensic ballistic examination, the term "munition" in relation to the cartridge used to fire small arms, is understood in the context of the use of a projectile element (bullets, buckshot, shot) on the target and causing it life-threatening injuries. This explains the difference in approaches to understanding the essence of the term in forensic, military and technical Sciences.

In technical science, a cartridge (ammunition) is understood as a device, i.e. a set of elements representing a single design (technical system) [66, p. 2]. The main functional purpose of this device is to ensure the production of a shot from a hand-held small-arms fire-strelnogo weapons and defeat the target.

Thus, due to the presence of a minimum sufficient set of design elements in the device of the cartridge (ammunition), the functioning of the technical complex "ammunition — weapon" as a single technical system is ensured. The use of the elements of this system in a disjointed form in order to achieve the expected results from the standpoint of existing scientific concepts is impossible, since a technical system is a set of interrelated elements combined into one whole to achieve some goal determined by its purpose [5, p. 9].

This is confirmed by the following example. The German firm Cuno Melcher in 1996 began production of pneumatic revolvers for firing from which the pneumatic cartridge Air-Cartidge is used, externally close in form and dimensional characteristics to a revolver cartridge of caliber 357 (figure 2.1.1).

Figure 2.1.1 — **General view of the cartridge "Air Cartridge" and the throwing elements used in it** [113, pp. 11–18]

Expert practice shows that the design features of this cartridge can be used to turn it into ammunition for hand-held small arms (figure 2.1.2).

Figure 2.1.2 — **General view of the homemade cartridge (left), the cartridge "Air Cartridge" (right)** [113, pp. 11–18]

In the center of the bottom of the sleeve of this cartridge is the stem of the nipple, closing the hole in the spout of the sleeve and preventing the exit of compressed air from it through the spout (figure 2.1.3).

Figure 2.1.3 — **General view of the structural elements of the cartridge “Air Cartridge” after dismantling** [113, pp. 11–18]

When exposed to the cartridge rod nipple opens, resulting in a bullet under the influence of excess pressure of compressed air is ejected from the cartridge.

Figure 2.1.4 — **General view of the bottom of the holder “Air Cartridge” (a, b) and improvised cartridge (c) represented in the study** [113, pp. 11–18]

In the study received by the State forensic center of the Ministry of internal Affairs of the Republic of Belarus pneumatic revolver “ME 38 Magnum-4,5 D” and five rounds of ammunition, it was found that one of the five cartridges were used cartridge parts “Air Cartridge”, ie sleeve with nipple and cap made of copper alloy (brass). In addition to these parts, a self-made metal cylinder with a length of 15.9 mm, a diameter of 8 mm, filled with a powder charge, was placed in the casing of the sleeve, a primer-igniter of the Central battle was mounted in one of the end sides of the cylinder (figure 2.1.4 c). Steel pointed bullets were used as projectiles. As an intermediate part for ignition of the initiating composition of the primer-igniter and the powder charge, the nipple rod of the sleeve itself served (figure 2.1.4 a, b).

In the four other cartridges presented for the study, only their shaped and dimensional characteristics fully corresponded to the characteristics of the cartridge "Air-Cartridge", and the sleeves themselves were completely made of brass. In the bottom of these sleeves are mounted caps-igniters of the Central battle (figure 2.1.4 c), and the propellant charge is placed directly into the housing of the sleeve and closed wad, which is placed on the bullet.

During the experimental firing to determine ballistic and destructive properties of pneumatic gun "ME 38 Magnum-4,5 D" using data cartridges was an expert experiment in which the measured initial speed of methane elements using hardware-software complex "Regula". According to the results of the experimental study, it was found that the initial velocity of the projectiles ranged from 255 m/s to 374 m/s. At the same time, the specific kinetic energy of the projectile elements of the cartridges repeatedly exceeded the lower limit of human damage (0.5 J / mm^2) [113, pp. 11–18].

According to the results of the study the expert formulated the following conclusions:

the cartridges presented for the study are ammunition;

the revolver under study in conjunction with these cartridges is a manual small arms firearm [113, pp. 11–18].

The analysis of process of improvement of cartridges (ammunition) used for firing from manual small arms, carried out in Chapter 1, testifies that emergence of new properties of these objects was caused including change of characteristics of the struck purpose (in more detail will be considered in section 3.4 of work). Properties of the system "munition-weapon", currently taken into account in military and technical science in the design of new types of cartridges (ammunition), in our opinion, should also be considered from the point of view of the affected target in relation to the tasks of forensic ballistic research. As already noted, the cartridge (ammunition) and a sample of hand-held small arms, for firing from which it is used, is an indivisible technical complex "ammunition-weapon", characterized by a set of certain ballistic properties in relation to specific conditions of use when hitting a certain target. Thus, in the specified system it is necessary to include also such element as the purpose as its properties define parameters of a technical complex "ammunition — weapon".

In order to analyze the properties of the munition — weapon system, it seems justified to consider it in more detail on the basis of the General characteristics of complex systems.

Complex systems are characterized by basic properties, respectively, requiring a systematic approach to the study. Such properties include: *integrity* — the system is considered as a single object consisting of interacting elements, unequal in essence, but compatible; *connectivity* — the presence of stable connections between the elements of the system and (or) their properties that determine its integrative properties; *organization* — the presence of a certain structural and functional organization that determines the possibility of creating a system; *integrativity* — the presence of qualities inherent in the system as a whole, but not peculiar to any of its elements individually (although the properties of the system depend on the properties of the elements, but are not determined by them in full) [5, p. 11].

From the point of view of forensic ballistics, the design of a cartridge (munition) generally consists of a projectile element (bullet, buckshot, shot), a propellant charge, an initiation device (capsule), combined by means of a sleeve [31, p. 66; 163, p. 35; 190]. The absence of at least one element in the design under consideration does not allow the cartridge to be classified as a "munition" in its forensic meaning. Each of the elements of the cartridge (ammunition) performs one or more functions. In particular, the *throwing element* is designed to directly hit the target as a result of firing from a hand-held small-arms firearm by giving it a certain speed of translational rectilinear motion as a result of the shot; *the initiation device* is designed to ignite the propellant charge of the cartridge (ammunition); *propellant charge* as a result of chemical transformation creates in the chamber of the sleeve and the barrel channel excess gas pressure, providing the process of firing; *the sleeve* combines all elements of the cartridge (ammunition) into a single device, provides obturation of the barrel bore and locking unit, protects the propellant charge and the initiation device from external influences [54, p. 188].

This allows you to determine the set of properties possessed by the cartridge (ammunition) from the point of view of forensic science. Such properties of the cartridge (ammunition) include the following:

it is a device structurally provided and functionally designed to engage a target at a distance as a result of firing from a hand-held small-arms firearm;

the design of the munition is a set of interrelated elements that ensure the functioning of the complex “munition-weapon” and implement its intended purpose — the location of the target at a distance;

defeat goal is undertaken moving in space single (bullet) or multiple (shot, buckshot) metaemym element of design patron (of ammunition);

the action of the thrown element on the target is single and non-renewable;

movement of the thrown element is provided by creation of excess pressure of gases in the closed volume of the cartridge case (ammunition) and (or) the channel of a trunk of manual small arms firearms;

overpressure of gases in the process of the shot is the result of irreversible chemical transformations in the combustion or detonation of the substances (powder, solid rocket fuel, liquid fuel and oxidizer, etc.), able in a short period of time to form the amount of gases to give the methane element required for its movement and the target speed;

the movement of the throwing element is oriented in the direction of the target, which is due to the historically developed design of hand-held small arms (the presence of the barrel or part of the shell casing);

the main striking property of the projectile element of the cartridge (ammunition) is the transfer of the target of the required amount of kinetic energy at the time of defeat.

Based on the above, the munition of hand-held small arms is a single-action device, structurally provided and functionally designed to hit the target with a throwing element as a result of firing [140; 143].

The proposed definition reflects the essence of the term based on the technical nature of the occurrence, as well as the specifics of forensic ballistic research of the objects in question. Application of this definition in practice at production of criminalistic research of the cartridges (ammunition) used for firing from manual small arms, will allow to provide the uniform methodical approach, to eliminate terminological limitation, to carry out differentiation of the similar terms used in adjacent areas of scientific knowledge, and thereby to increase quality, reliability and validity of expert conclusions.

The given definition, in our opinion, reflects sufficient for the solution of problems of forensic ballistic examination set of the following defining essence of the cartridge (ammunition) of manual small arms firearms signs:

functional (target) purpose — the purpose of the cartridge design to defeat the target as a result of firing from the corresponding sample of hand-held small arms;

structural security — the presence in the structure of the minimum required number of elements required for its operation;

complexity — the Union of different purpose of structural elements in a single device;

single use — the possibility of a single use for the intended purpose;

defeat of the purpose as a result of firing by the thrown element with sufficient level of striking properties-possibility of causing the penetrating injuries dangerous to life and health of the person.

The analysis of practical activity of expert divisions testifies that now as objects of forensic ballistic examination the set of types of cartridges (ammunition) differing from each other in a way of production, features of a design, technical characteristics and ballistic parameters acts. In connection with the progressive and dynamic development of science and technology, new types of cartridges (ammunition) have been developed, information about which is not even available in the reference literature. This makes it necessary to systematize the available information about cartridges (ammunition), their elements, since the question of attribution of cartridges to the category of ammunition is associated not only with their concept, but also with the classification and systematization of knowledge and their application.

In forensic Science, system-structural and classification approaches are widely used. This is due, on the one hand, to the need for a permanent organization of science itself as an object in continuous development in order to create a broad scientific potential, and on the other hand, the need for effective, scientifically based application of this potential in practice [30].

Classification of objects of research in the theory of forensic examination is an essential condition for the effective solution of the problems of expert research. Only in the presence of the developed classification system, the most complete and comprehensive study of objects based on the choice of the optimal method of their study is possible [95, p. 44]. Based on dialectical principles, classifications transfer the focus to the disclosure of internal, natural connections between groups of classified objects, reflect the moment of their origin and change, logical connections and relationships between them, while they must have maximum flexibility and exclude artificiality, arbitrariness and subjectivism.

At the same time, E. N. Tikhonov emphasizes that a properly formed classification should be accessible for use, visual, due to the needs of practice, allow the use of additional grounds if necessary [259, pp. 16–17].

As in the theoretical sources devoted to the forensic ballistic study of cartridges (ammunition) used for shooting from small arms, and in the methods of expert research of these objects there is no clear system of established grounds for classification, while from the point of view of forensic science they are essential, in particular in determining the source of evidentiary information. In the process of investigation and disclosure of the crime tools and means of its Commission are considered, as a rule, in connection with the establishment of the method of Commission of the crime, the identity of the offender, but at a certain stage they may have an independent value, for example, in determining the common origin, search tools and subsequent identification to determine [71, p. 158].

Following the rules of formal logic, the basis of classification should occupy a strictly defined place in it and should be designed for long-term use without any significant changes. Thus, the main task of classification is to systematize the field of knowledge to facilitate orientation in both scientific and practical activities. However, any classification is the result of the application of certain assumptions that define the boundaries of certain types of classified objects [275, p. 177].

Based on the above, from the point of view of materialistic dialectics, it seems reasonable to consider the currently existing classifications of cartridges (ammunition) used in criminology, forensic ballistics and forensic medicine.

Thus, A. G. Egorov, A. V. Stalmakhov, A. M. Sumarokov and A. G. Sukharev developed a classification of cartridges (ammunition) for hand-held firearms as objects of forensic research on the following grounds:

1) in structure — unitary, non-unitary, caseless;

2) at the location of the initiating composition — cartridges Central combat, the cartridges ring of ignition, cartridges side ignition (conifers);

3) for the intended purpose-combat (army, police), civilian (hunting, sports, gas), simulation (idle, noise, training), verification (to check the trunks, locking device, ballistic properties of weapons);

4) by caliber-small caliber (less than 6.5 mm), normal caliber (6.5–9 mm), large caliber (more than 9 mm);

5) by type of weapon used — rifle, intermediate pistol, revolver;

6) according to the method of manufacture-industrial, homemade;

7) in relation to the weapon in which they are used, — regular, cartridges-substitutes, non-standard [248, pp. 43–45].

A similar classification with minor differences is introduced in the works of V. L. Popov, V. G. Shigeev and L. E. Kuznetsov [211, pp. 35–36], V. A. Buri [31, pp. 46–49] and S. V. Yatsenko [303, pp. 53–54]. At the same time, the authors develop the classification approach set forth in the works of such founders of domestic forensic ballistics as V. F. Chervakov [281, pp. 54–64], B. M. Komarinets [102, pp. 59–97] and E. N. Tikhonov [253, pp. 11–14].

S. V. Yatsenko cartridges (ammunition) to manual small arms in addition classifies on two bases:

1) according to the mechanism of the damaging action-kinetic action, irritating action (equipped with substances-irritants), light-sound action;

2) by efficiency of mechanical striking action-cartridges-ammunition, cartridges of limited striking action (the value of their specific kinetic energy is less than 0.5 J/mm ^{2}) [303, pp. 55–56].

I. V. Gorbachev and O. V. Miklyaeva cartridges (ammunition) are classified similarly on such grounds as design and method of production. In addition, depending on the method of initiation of the propellant charge, these objects are divided by the authors into cartridges (ammunition): with shock ignition (spike cartridges, ring ignition cartridges, Central battle cartridges), with electric ignition. Some difference is also proposed by the authors of the classification of cartridges (ammunition) using such grounds as functional purpose, in connection with which they are allocated military (primary and auxiliary), service, civil (hunting and self-defense weapons) cartridges (ammunition) [112, pp. 40–54].

In particular, in The methodology of forensic research of cartridges, cartridges were classified only by their design, on the basis of which its authors identified unitary loading cartridges, non-unitary cartridges and cartridge-free cartridges [163].

The analysis of the given classifications of cartridges (ammunition) as objects of criminalistic research allows to draw a conclusion that in them the approaches developed by judicial ballistics in the course of its formation and development are used. At the same time, the attribution of cartridges (ammunition) to some groups is not fully justified due to the lack of a clear understanding of the technical device of these objects of expert research.

In the above scientific classifications, methods of forensic research of cartridges (section "Concept and classification of cartridges") are allocated such types of cartridges as non-unitary. In our opinion, this position is controversial on the following grounds:

1) the term "not unitary patron" in military science and technical literature on designing patrons is missing, under him is understood ambivalent patron separate loading, used in XVI — the eighteenth centuries for called the shots from dulnozaryadnogo manual rifle firearms. The elements of this cartridge United by means of a paper sleeve are not a device from a technical point of view, but represent a set of objects United in a design for protection of a propellant charge from external influences and increase in speed of loading. Currently this kind of patron in practice expert research virtually not meets in view transition to use of for called the shots from manual rifle firearms unitary patrons. Thus, the allocation of it as a separate type of ammunition is debatable and hardly justified, since in accordance with the provisions of the methodology of forensic research of cartridges, such a cartridge is not ammunition;

2) the division of cartridges for the intended purpose (army, police, civil, simulation, testing) is also not fully justified, since some of the terms given in the classification, in fact, replace the technical terms and their definitions enshrined in technical regulations, which more fully characterize the objects under study. This does not contribute to achieving the unity of scientific terms and unification of the conceptual and categorical apparatus of forensic ballistic examination, which in practice can lead to ambiguous perception and different applications, since from the point of view of technical science, for example, there are no clear criteria for distinguishing between "army" and "police" cartridges (ammunition) for hand-held small arms.

Thus, the Armed Forces of the Republic of Belarus, the Ministry of internal Affairs of the Republic of Belarus and other agencies with a paramilitary structure are armed with cartridges (ammunition) 9×18Mak (51-N-181S) with a three-element bullet with a steel core. Replacement of the specified type of ammunition by the cartridge 9×18Mak (51-N-181) in which bullet the steel core is absent, does not change its properties at transfer from the category of fighting cartridges (ammunition) to the category "police". The 9×18Mak cartridge (51-N-181) was developed according to the Tactical and technical requirement No. 3110 of November 26, 1945. The main artillery Department of the Ministry of defense of the USSR in connection with the replacement of the cartridge (ammunition) 7.62×25 to the TT pistol and was adopted, but due to insufficient striking action was subsequently replaced by a cartridge 9×18Mak (51-N-181S) [57, pp. 165–190].

To substantiate the above point of view, it is necessary to refer to the works on the design of cartridges (ammunition), as well as the technical requirements for the complexes "weapon-cartridge" used in various fields (military, service, civil). At the same time, the main properties of rifle complexes "weapon-cartridge" are as follows:

1) *combat* designed to defeat manpower and equipment in the conduct of hostilities;

2) *civilian*-designed for sports, hunting, self-defense. Includes a hand-held small arms with a smooth or rifled bore; the design of bullets cartridges (ammunition) should not contain cores of solid metal, tracers, incendiary, explosive, other pyrotechnic compositions; powder charge cartridge (ammunition) is strictly regulated, provides a short range of the projectile element and reliable extraction of spent cartridges. The main requirement is safety in handling and reliability of operation;

3) *service*-is intended for use by employees of legal entities with special statutory tasks, which are permitted by law to carry, store and use these weapons in self-defense or performance of their duties by law. Should meet the technical requirements similar to those for civilian; for official purposes, as a rule, hand-held small firearms with muzzle energy of not more than 300 J [54, pp. 34–35].

Thus, the above confirms the conclusion that the division of cartridges (ammunition) depending on the scope of their application, established by The law "On Weapons", is not fully justified. The main criteria for attributing cartridges (ammunition) to a particular category are the features of their design and ballistic parameters of the throwing element when fired.

With regard to the topic of the study, we have developed a refined classification of cartridges (ammunition) used for shooting from hand-held firearms. When constructing the classification, the point of view of T. V. Averyanova was taken into account, according to which the process of building a forensic classification consists of three stages: 1) selection of a set of objects to be studied; 2) indication and precise definition of features, taking into account which the comparison will be made; 3) the method of differentiation of objects, i.e. the algorithm of their allocation in classes [2, p. 32].

At the same time, it is taken into account that the design of cartridges (ammunition) to manual small arms (regardless of the scope of its application) has minor differences, which allows you to apply a single system of classification. The following characteristics of the "munition — weapon — target" system were used as genus-specific features":

1) in relation to hand-held small arms-its intended purpose, the power of the muzzle energy, caliber, length of the barrel;

2) with regard to ammunition-the presence and type of striking (throwing) elements, the sleeve and its material; the method of initiation of the propellant charge and the location of the initiating substance or device; the method of manufacture;

3) characteristics of the vulnerability of the target, the environment of defeat.

The developed classification is based on the classification proposed by experts in the field of projecting cartridges for hand small arms by G. A. Danilin, V. P. Ogorodnikov and A. B. Zavolokin [54, pp. 42–45], which is refined taking into account the tasks of forensic science and the requirements imposed by the practice of forensic research of these objects.

Proceeding from the specified, depending on characteristic features of manual small arms firearms for firing from which cartridges (ammunition) are applied, they are classified as follows:

I. For the purpose of small firearms — ammo (ammunition):

1) to combat manual small arms firearms;

2) to service manual small arms firearms;

3) to civilian hand held small arms.

Classification on the specified basis is made taking into account such technical characteristics of the complex “ammunition — weapon” as the value of muzzle energy, and other design features welded elements, namely: the absence in the design of bullets to service and civilian small firearms cores of solid materials, significant deformation in the defeat of purpose, the impossibility of breaking through the individual means of body armor (a direct ban on the use of service and civilian weapons bullets into the design which are the cores of solid materials directly contained in the second paragraph of article 6 and the second paragraph of article 7 of the Law “On Weapons”).

II. Power of small firearms (the amount of muzzle energy) — the bullets (ammunition):

1) to hand-held small-bore firearms with low muzzle energy (<1000 J);

2) to manual small arms firearms with medium muzzle energy (1000–3000 J);

3) to hand-held small-arms firearms with large muzzle energy (>3000 J).

The criteria are based on the interrelated properties of a complex “ammo — weapon” as the value of the powder charge, barrel length, caliber of weapons, and other parameters considered the rate of internal ballistics.

III. According to the construction of trunk of small firearms — ammo (ammunition): 1) to rifled hand held small arms firearms; 2) to smoothbore hand-held small firearms.

IV. Along the length of the barrel of hand — held small arms-ammunition (ammunition): 1) to long-barreled hand-held small arms (>400 mm); 2) to medium-sized hand-held small arms (>200–400 mm); 3) to short-barreled hand-held small arms (≤200 mm); 4) to barreled hand held small arms.

V. By caliber of hand-held small-arms firearms-cartridges (ammunition) (except for cartridges for smoothbore hunting and barreled hand-held small-arms firearms): 1) small caliber (≤6.5 mm); 2) medium caliber (>6.5–9 mm); 3) large caliber (>9 mm–20 mm).

VI. According to the ratio of the diameter of the throwing element with the caliber of the barrel of a hand-held small-arms firearm, cartridges (ammunition): 1) caliber; 2) sub-caliber.

VII. Depending on the type of hand-held firearms-cartridges (ammunition): 1) pistol; 2) revolver; 3) intermediate; 4) rifle; 5) rifle.

VIII. By type of striking action of the thrown elements, — cartridges (ammunition) with the thrown elements: 1) simple (kinetic) action; 2) special action; 3) combined action.

IX. Depending on the speed of flight of the thrown elements-cartridges (ammunition): 1) with subsonic speed of the thrown element; 2) with supersonic speed of the thrown element.

X. By type of the thrown element — cartridges (ammunition): 1) with metal thrown elements; 2) with thrown elements from composite materials.

XI. By the number of striking throwing elements — cartridges (ammunition): 1) with one striking element; 2) with two striking elements; 3) with three striking elements; 4) with multiple striking elements.

XII. Depending on the properties of the environment — cartridges (ammunition): 1) for shooting in a gas environment (atmosphere); 2) for shooting in a liquid environment (under water); 3) for shooting in mixed conditions.

XIII. By the presence of the sleeve in the design of the cartridge (ammunition) — cartridges (ammunition): 1) sleeve (with metal, bimetallic, plastic and combined sleeve); 2) with a burning (pyrotechnic) sleeve; 3) unsleeved.

XIV. According to the method of actuating the means of initiating the propellant charge-cartridges (ammunition): 1) with shock initiation; 2) with electric initiation.

XV. On placement of initiating structure: 1) cartridges (ammunition) of the Central fight; 2) cartridges of ring ignition; 3) cartridges of lateral ignition (study).

XVI. Depending on the method of manufacture-cartridges (ammunition): 1) factory-made; 2) self-made; 3) partially or completely re-equipped with elements of cartridges factory-made (figure 2.1.5) [143].

CARTRIDGES (ammunition)

I. For the purpose of manual small arms firearms — cartridges (ammunition):
1) to combat manual small arms firearms;
2) to service manual small arms firearms;
3) to civilian hand held small arms.

II. Power of small firearms (the amount of muzzle energy) — cartridges (ammunition):
1) to hand-held small arms with low (<1000 J) muzzle energy;
2) to manual small arms with average (1000–3000 J) muzzle energy;
3) to hand-held small arms with high (>3000 J) muzzle energy.

III. According to the construction of trunk small firearms — cartridges (ammunition):
1) to rifled hand held small arms firearms;
2) to smoothbore hand held small arms firearms.

IV. Along the length of the barrel of a hand-held small-arms firearm — cartridges (ammunition):
1) to long-barreled (>400 mm) hand-held small firearms;
2) to medium-bore (>200 mm–400 mm) hand-held small firearms;
3) for manual small arms medium caliber (>200 mm-400 mm);
4) to barreled hand held small arms.

V. According to the caliber of hand-held small firearms — cartridges (ammunition) (except cartridges for smoothbore hunting and barreled hand-held small arms):
1) small caliber (≤6.5 mm);
2) medium caliber (>6.5 – 9mm);
3) large caliber (>9 mm – 20 mm).

VI. By the ratio of the diameter of the throwing element with the caliber of the barrel of hand-held small firearms cartridges (ammunition):
1) caliber;
2) subcaliber.

VII. Depending on the type of hand-held firearms — cartridges (ammunition):
1) pistol; 2) revolver; 3) intermediate;
4) rifle; 5) weapons.

VIII. By type of striking action of the thrown elements — cartridges (ammunition): with a welded item:
1) simple (kinetic) action;
2) special action;
3) combined action.

IX. Depending on the flight speed of the thrown elements — cartridges (ammunition):
1) with subsonic velocity of the thrown element;
2) with supersonic speed of the thrown element.

X. By type of throwing element — cartridges (ammunition):
1) with metal throwing elements;
2) with throwable elements made of composite materials.

XI. By the number of striking throwing elements — cartridges (ammunition):
1) with one striking element;
2) with two striking elements;
3) with three striking elements;
4) with multiple striking elements.

XII. Depending on the properties of the environment — cartridges (ammunition):
1) for shooting in a gas environment (atmosphere);
2) for shooting in liquid environment (under water);
3) for shooting in mixed conditions.

XIII. By the presence of the sleeve in the design of the cartridge (ammunition) — cartridges (ammunition):
1) sleeve (with metal, metal, plastic and combined sleeve);
2) with a burning (pyrotechnic) sleeve;
3) caseless.

XIV. According to the method of actuating the means of initiating the propellant charge — cartridges (ammunition):
1) with shock initiation;
2) with electrical initiation.

XV. At the location of the initiating composition cartridges (ammunition):
1) cartridges of the Central fight;
2) cartridges ring of ignition;
3) the ammo side of ignition (conifers).

XVI. Depending on the method of manufacture — cartridges (ammunition):
1) factory made;
2) self-made;
3) partially or completely reloaded using elements of cartridges of factory production.

Figure 2.1.5 — **Classification of cartridges (ammunition) manual small arms firearms**

Compared with the existing classification more fully reflects the technical essence of cartridges (ammunition) as objects of forensic research. In addition, this classification is more informative, easier to navigate the variety of existing cartridges (ammunition), allows to predict ways to improve the design of these objects as a whole and their individual elements, facilitates the process of forensic investigation to determine the type (types) of the cartridge (ammunition), determine the type of small firearm, for firing from which they can be used. Nevertheless, it should be noted that the principle of relativity of the bases of any classification implies a deliberate insufficiency of their structure and classified objects. In addition, as already mentioned, the process of creating and improving the designs of cartridges (ammunition) is characterized by a certain dynamism. In this regard, the allocation of an exhaustive list of grounds for any classification is impossible in principle.

Thus, stated in this section of work allows to draw the following generalized conclusions:

1. The definitions of the term “munition” contained in the forensic literature do not fully meet the goals and objectives of forensic ballistic examination, since they do not sufficiently reflect the necessary set of features inherent in these objects of forensic research. The discrepancy between the terminology used in normative legal acts regulating the legal regime of firearms turnover and the terminology used in technical normative legal acts is due to differences in the purpose of the relevant terms and their definitions, in connection with which the use of terms contained in normative legal acts in the process of forensic ballistic examinations should be optional.

2. In the process of forensic ballistic research experts, in addition to the established theoretical and methodological provisions of forensic ballistics, should also take into account the provisions of technical regulations that establish the technical parameters and standards applicable to the processes of development, production, operation (use), storage, transportation, sale and disposal of hand-held small arms, as well as cartridges (ammunition) used for firing.

3. In order to eliminate the inconsistency of terms and their definitions contained in the Law “on weapons”, and the relevant terms and their definitions used in other normative legal acts regulating public relations related to cartridges (ammunition) used for shooting from small arms, it is necessary to develop a unified terminological apparatus with

its consolidation in the methods of expert research for implementation in the practical activities of expert units. Taking into account the provisions of technical regulations, methods of forensic research of cartridges (ammunition) in improving the provisions Of the law “On Weapons” will increase the validity and reliability of the conclusions of forensic ballistic examinations.

4. With regard to the purposes of forensic ballistic examination, the following definition of the term is proposed: a munition of small arms is a single-action device, structurally provided and functionally designed to hit the target with a throwing element as a result of firing.

This definition reveals the essence of the concept of “ammunition” as an object of forensic research on the basis of the following defining its essence features: 1) functional (target) purpose; 2) structural security; 3) multicomponent; 4) single-use; 5) impact on the target as a result of firing a throwing element with a sufficient level of striking properties.

The proposed definition expresses the dialectical nature of the objective conditions, functional and constructive features of the object of forensic research, clarifies the terminology used in forensic science, the theory of forensic ballistic examination in order to accurately and uniformly understand the essence of these objects both in the process of forensic ballistic examination, and in assessing the reliability of the conclusions.

5. The analysis of the classifications of cartridges (ammunition) contained in the scientific literature on forensic ballistics and forensic medicine indicates the incompleteness of the bases used and the types of classified objects in relation to the tasks of their forensic research, which is due to the difference in forensic, technical and legal approaches to determining the properties of cartridges (ammunition) used for shooting.

6. As criteria of reference of cartridges (ammunition) to fighting, office, civil should serve not the technical signs of their device fixed in normative legal acts (in relation to the legislation of the Republic of Belarus — in the paragraph the second of article 6 and the paragraph the second of article 7 of The law “On Weapon”), and characteristics of system “ammunition — the weapon — target”, which are the value of the muzzle energy and such features of the design of the projectile element of the cartridge (ammunition), as the absence of bullets in cartridges

(ammunition) to service and civilian weapons cores of solid materials tracer, incendiary, explosive or pyrotechnic compositions, as well as the vulnerability of the target.

7. The classification rounds (ammunition) used for shooting from manual small arms firearms designed AV-Thor based set of signs of the system "ordnance — weapons — target", including the appointment of a cartridge (ammunition); the power of small firearms; the design of the barrel; barrel length; calibre; the ratio of the diameter of a welded element ka-librom a barrel; a hand of small firearms, which they used for firing; view of the damaging effect of methane element; the speed of his flight; the type of material from which it is made; the amount of methane elements in the design of the cartridge (ammunition); environmental characteristics of the lesion; presence of shells; a method of initiating a propellant charge; a method of manufacturing a cartridge (ammunition); the location of the initiating composition; the security objective means of individual protection.

2.2. Forensic properties and design features of cartridges (ammunition) for hand-held firearms

In the process of forensic ballistic examination of cartridges (ammunition) used for shooting from hand-held firearms, specific objects of the material world are investigated. Currently, a sample of hand-held small arms with a cartridge used in it for firing is considered as an integral complex "weapon — cartridge", the elements of which have an impact on each other in the process of functioning.

The founder of the Soviet forensic ballistics V. F. Chervakov put forward the now universally recognized thesis that, along with the study of traces of hand firearms, cartridges (ammunition) to it, it is necessary to study their material part [281, pp. 5–6].

The cartridge (ammunition) provides realization of the main purpose of manual small arms firearms-defeat of the purpose. Currently, the process of improving small arms is characterized by the search for solutions to improve its effectiveness, the main of which is the improvement of the design of cartridges (ammunition) and its individual components [32, p. 7]. As noted in the literature, given that the operation of hand-held small arms is carried out only in the process of using it for firing cartridges (ammunition), the task of improving them is relevant, since they largely depend on its effectiveness. In this regard, the development of their design should go the way of increasing the action of projectiles at the target by improving all the constituent elements of the design of cartridges (ammunition) [288, p. 3].

The unitary cartridge as a complex product (device) is used in manual small arms since the middle of the XIX century. At the same time, to date, its design has not undergone any significant changes. In this period, the process of improving the manual small arms is characterized by the search for solutions to improve its efficiency, the main of which is to improve the design of cartridges (ammunition) and its individual components.

The analysis of literary sources testifies that considered earlier in separate works on judicial ballistic examination such perspective designs of cartridges (ammunition) as bezgilzovye, reactive, mnogopulnye, with an l-shaped sleeve, to manual small arms with an open chamber did not receive the further development, and works on development and improvement of their design were curtailed [56, pp. 27–90].

In connection with the significant development of science and technology, new types of cartridges (ammunition) have been developed, information about which is not available in the forensic literature. Based on this, it seems reasonable to consider ways to improve the design of cartridges (ammunition) and its individual elements, since this direction is currently dominant in the design of cartridges (ammunition) for handheld firearms.

For a long time the development of new samples of cartridges (ammunition) was carried out empirically with a focus on the practice of operation of similar products. In the 1970s and 1980s, on the basis of fundamental technical research, a rational system of projecting cartridges (ammunition) was developed, which began to use methods of ballistic calculations, evaluation of the effectiveness of action on the target, etc. Modern methods and developments of shooting complexes are based on data of internal, external and wound (terminal) ballistics, at the same time the system analysis and modern achievements of computer technology are used [242]. The need for such an approach is determined by the complexity of the design of cartridges (ammunition) and small arms, characterized by versatility, the use of new materials, the use of advanced technologies in their manufacture.

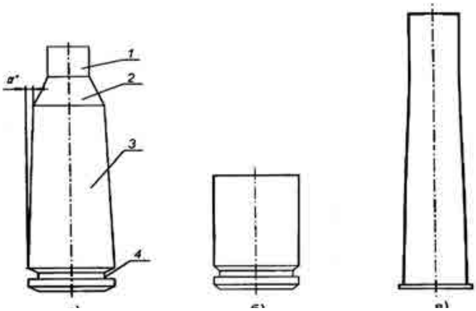
Taking into account the above, it seems reasonable to study not only the previously existing and modern samples of cartridges (ammunition) used for shooting from small arms, but also the promising directions of development of their design and its individual elements, which determine the properties acquired by them in the process of improvement, in relation to the tasks of forensic ballistic examination, since the process of creation and modernization of these objects of forensic ballistic research is continuous.

Historically, the unitary construction of the cartridge (ammunition) used for firing from small arms, as already stated, consists of four main components: the sleeve, the device initiating the propellant charge (primer-igniter), meta-tive charge (charge of propellant), methane element (part of the cartridge (ammunition) designed specifically to defeat the purpose). In addition to these elements in the design of the cartridge (ammunition) may also include optional elements (containers, wads, gaskets, etc.).

Within the framework of the studied question, it seems justified to consider each of these basic elements of a unitary cartridge (ammunition) in more detail.

Sleeve. At the present stage of development of the design of the cartridge (ammunition) one of its integral components is the sleeve. Its main purpose is to connect all elements of the cartridge (ammunition) in a single device, enabling the automation of the firing process, long-term preservation of the initiating composition and propellant from the effects of environmental factors, obturation of the chamber and the shutter arms of the breakthrough of the powder gases in the process shot, long-term storage of ammunition (for live ammunition in sealed packaging — up to 50 years, without compromising the basic properties) [54, p. 188; 90, p. 182].

In accordance with the GOST of the USSR 28653-90 “of Weapons. Terms and definitions” [190] depending on the form, there are three types of sleeves: 1) bottle; 2) cylindrical; 3) conical (figure 2.2.1).



a) b) c)

Figure 2.2.1 — **Sleeve shape:** a — bottle; b — cylindrical; c — conical; 1 — cartridge case muzzle; 2 — slope; 3 — body; 4 — bottom part; a^0 — the angle between the generator and the axis of the sleeve (cylindrical and conical sleeves are not marked)

Based on the functional purpose, each element of the cartridge case (ammunition) corresponds to a certain shape and size characteristics.

Cylindrical sleeves are named so conventionally, because, like the bottle-shaped sleeve, their body has a certain taper (a° = 0°30’...1°) to facilitate charging and extraction processes. The shape of the conical sleeve is transitional from cylindrical to bottle. Cartridges with a sleeve of this form were previously used in rifled hunting firearms, as well as some samples of pistols and revolvers (currently produced in limited batches). There are also casings with a reverse taper, but they are not used in cartridges for hand-held small arms.

In the device of the bottle sleeve there are four main elements: the muzzle, the ramp, the body and the bottom part. In cylindrical and conical sleeves the muzzle and the ramp are absent.

The muzzle of the sleeve serves for a strong fixation in it of the projectile (bullet) and improving the obturation of powder gases, in some samples of firearms with the help of the muzzle, the fixation of the cartridge in the chamber is provided.

Cartridge sleeve cut — end part of the sleeve from the side of its open part.

The ramp of the sleeve is a transitional section from the muzzle to the body and is designed for obturation of powder gases when fired, is a fixing element and a means of extinguishing the kinetic energy of the cartridge (ammunition) in the process of loading.

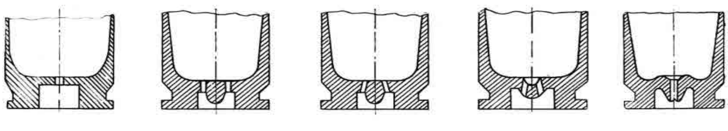
The housing of the sleeve is designed to accommodate the propellant charge and protect it from external influences, the upper part of the housing of the sleeve provides obturation at the time of the shot. The thickness of the walls of the shell casing from the top to the bottom gradually increases and increases at the bottom.

The bottom part of the sleeve is designed to place in it a device for initiating a propellant charge, locking the barrel channel, sending the cartridge into the chamber, reducing the deformation of the housing and the flange of the sleeve when firing. The inner surface of the bottom part of the sleeve may be flat or have a protrusion in the Central part, which houses the socket for the primer-igniter and the ignition holes for ignition of the propellant charge. Ignition holes are formed as a result of drilling or punching with needles. The outer surface of the bottom part of the sleeves is made flat, usually with embossed markings.

The bottom part of the sleeve may include a groove, flange, partition, ignition holes, primer socket, anvil and the end of the bottom part.

Cartridge case partition — a wall in the bottom of the cartridge case that separates the capsule socket of the cartridge case from the charging chamber.

The bottom part of the non-metallic sleeve (for smoothbore hunting weapons) includes a pallet and the base of the sleeve.



a b c d e

Figure 2.2.2 — **Main types of construction of bottom part of sleeves (in a section):**
a — with capsule socket without anvil;
b — with anvil and two vertical firing holes;
c, d — with anvil and two inclined ignition holes;
e — with one ignition hole in the anvil

In the form of the bottom part is allocated: 1) flange (Welt) (with full-size and partially protruding flange); 2) flangeless (Weltless); with a small flange; with an annular projection (figure 2.2.3).

a b c d e

Figure 2.2.3 — **Cartridge cases with different bottom shape:**
a — with a full-size flange (R); b — with partially protruding flange (SR);
c — flangeless; d — with a small flange (r); e — with annular projection (B)

According to the European standard C. I. P. of the Permanent International Commission for testing of hand-held firearms (PMK), the name of the cartridge indicates its caliber, the length of the sleeve in millimeters, as well as the presence of a protruding flange (Rant (R) — the protruding flange). Less often specified type of weapon, the purpose of the cartridge and the weight of the bullet (Browning (Br) — weapon model).

Example:

7,62×54R — 7.62 mm rifle cartridge to 7.62 mm Mosin design rifle with 54 mm sleeve length and protruding flange;

7,65×17SR or 7.65×17Br — 7.65 mm pistol cartridge with a sleeve length of 17 mm with a partially protruding flange (Semi Rimmed (SR) — sleeve with a partially protruding flange);

6,35×15Br or a 6.35×15.5 — 6.35 mm pistol cartridge with a 15.5 mm sleeve length with a partially protruding flange;

9×18 Mak — 9-mm pistol cartridge to 9-mm pistol Makarov design with a sleeve length of 18 mm.

If the cartridge has several well-established names, including in countries where the American and English designation systems are used, then it is advisable to indicate its second name in the text of the examination.

Example:

5,6×16R (.22 LR) — 5.6-mm sport-hunting cartridge ring ignition with a sleeve length of 16 mm and a protruding flange (Long Rifle (LR) — long screw-tow) to 5.6-mm Margolin pistol, 5.6-mm TOZ rifle -8;

7,62×63 (.30-06 Springfield) — hunting cartridge for M1 Garand self-loading rifle, hunting carbine “Ceska Zbroevka” CZ 557 with sleeve length 63 mm;

6.35×15Br (.25 ACP*)* — 6.35-mm pistol cartridge with 15.5 mm sleeve length with partially protruding flange.

The method of fixation in the chamber distinguish cases with emphasis (figure 2.2.4): cut housing sleeve to the ledge of the chamber (with its cartridge case in the Cup in the chamber); stingray in the chamber Stingray; a ledge on the body of the sleeve in the bore of the breech of the barrel; a flange recess in the breech; partially protruding flange in the breech muzzle.

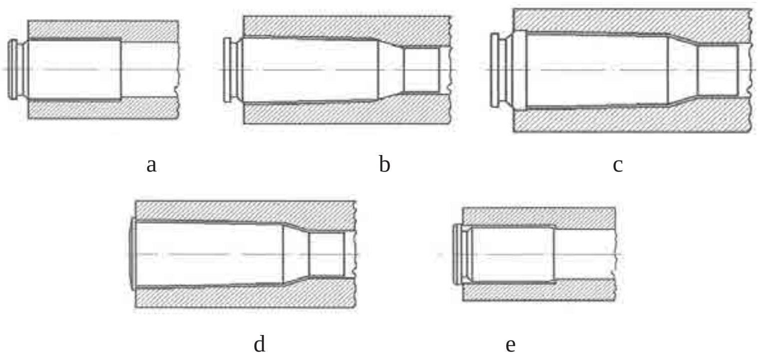


Figure 2.2.4 — **Fixation of the sleeve in the chamber of small arms firearms:** a — cut the shell casing in the chamber ledge; b — Stingray in the chamber Stingray; c — ledge on the body of the sleeve in the recess of the breech of the barrel; d — flange into the recess of the breech of the barrel; e — partially protruding flange into the breech section of the barrel

Depending on the design there are two types of cartridges for firearms: a) seamless (one-piece) and b) collapsible. At the same time, prefabricated sleeves with a polymer and cardboard body are used mainly in the design of cartridges (ammunition) for hunting smoothbore weapons.

According to the material of manufacture sleeves are divided into: a) sleeves made of metal construction materials (low carbon steel, brass, bimetal); b) sleeves made of non-metallic materials (cardboard, polymeric materials); c) sleeves burning (pyrotechnic).

Cartridge cases with a body made of polymeric materials are used primarily in cartridges for smoothbore hunting weapons and weapons with limited striking ability (traumatic weapons) [54, p. 192].

One of the main elements of the cartridge equipment for smoothbore hunting hand-held small arms is the choice of the type of sleeve used in it, among which there are: sleeves with a polymer body; sleeves with cardboard body; all-metal sleeves; all-plastic sleeves.

Currently a significant number of cartridges for smoothbore hunting hand held small arms are equipped with the use of a sleeve with a polymer body. The design of such a sleeve contains a metal base, a housing (polymer tube) and a pallet (figure 2.2.5).

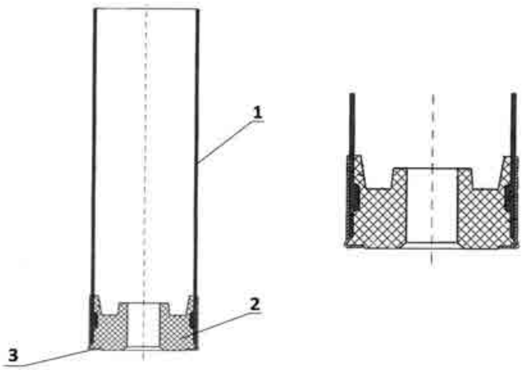


Figure 2.2.5 — **The device of the collective cartridge case to the smoothbore hunting weapon:** 1 — housing (polymer or cardboard tube), 2 — liner tray, 3 — the base of the sleeve; **enlarged fragment of the base of the sleeve**

In the development and manufacture of cartridges (ammunition), designed for shooting from smoothbore hand-held small hunting weapons, the following features are taken into account in the industry:

the dimensional characteristics of the cartridge, subject to control from a security point of view, as well as the main part of the dimensions to be controlled from the point of view of typical supplies determined by the container size;

the internal dimensions of the sleeve are not standardized and may vary depending on the manufacturer;

the landing diameter of the capsule socket of the sleeve is not normalized and is determined by compatibility with the primer-igniter;

the primer-igniter is installed in the primer socket with a force that excludes the possibility of its displacement when fired, deformation and destruction of the pressing of the initiating composition;

the primer-igniter is installed in the capsule socket of the cartridge sleeve until it stops, thereby eliminating the possibility of losing part of the energy of the striker with his knee pads.

The metal base is made by stamping a steel strip 0.3–0.4 mm thick, covered with tompak. Obturation of powder gases at a shot from manual small arms firearms is provided at the expense of increase in diameter of the metal basis up to the stop in walls of a chamber and restoration of the initial size after pressure removal. With a sufficiently significant residual plastic deformation, the diameter of the metal base after the shot can remain increased and prevent the free extraction of the spent sleeve from the chamber of the hand-held small arms, creating favorable conditions for trace formation. In this case, removing the spent cartridge case may require considerable effort. In this case, the low strength of the sleeve flange in combination with a small area of the ejector gun can cause deformation of the flange and the ejector failure, after which the extraction of the spent sleeve is possible only with the help of a ramrod from the muzzle of the barrel.

The weakening of the design, due to the reduction of the strength of the sleeve body to the metal base, can cause the dismantling of the sleeve, which, in turn, can be accompanied by ejection of the sleeve body from the barrel or its jamming in the chamber or the barrel channel. The case of the sleeve stuck in the chamber can prevent infection of the next cartridge or its extraction. The body stuck in the barrel channel, although it does not prevent the loading of the next cartridge, during the production of the shot can lead to a rupture of the barrel of the weapon.

The polymer body of the cartridge case of hunting cartridges (ammunition) to smoothbore hunting hand-held small arms, as a rule, is made of polyethylene. The thickness of the shell wall is about 0.7–0.8 mm; the inner diameter for 12 gauge sleeves varies between 18.6–18.8 mm. In most cases the liner pallet is also made of polyethylene by injection molding.

In the industry, sleeves with a metal base height of 8, 12, 16 and 25 mm are widespread, sleeves with a metal base height of 20, 22 and 27 mm, respectively, are less common. In this case the actual height of the metal base of the sleeve may differ from the nominally installed in the processing ±1 mm. The height of the pallet for all sizes of sleeves in most cases is 10–12 mm. Sleeves, the height of the metal base of which is about 8 mm, are used for equipment of mass sports and cheap hunting cartridges. Liner with metal base height of 12 mm can be used for equipment sporting and hunting weapons; core height 16 mm — for equipment of cartridges are high quality cartridges with a length of 76 mm Magnum and 89 mm “Supermagnum”; core height 20 to 27 mm — only for equipment of cartridges of the highest class.

In most cases, the designation of the sleeve size includes the caliber, the length of the body and the height of the metal base. For example, the designation 12-76-16 or 12/76/16 refers to the cartridge case of a hunting cartridge to a 12-gauge smoothbore hand-held small-arms firearm with a body length of 76 mm and a metal base height of 16 mm.

The polymer casing of the sleeve can have different colors, be colorless, transparent and opaque. Sleeves with colorless transparent polymeric cases are used, as a rule, for equipment of hunting bullet cartridges (ammunition) of high price category.

Currently in industry there is a restriction on the use of sleeves with a polymer body of yellow color when equipping cartridges. For cartridges of 20 caliber to smoothbore hunting manual small arms the sleeves with the polymeric case of only yellow color shall be used, cartridges of other calibers can be equipped with use of sleeves with tubes of any color, except yellow.

In addition, the sleeves can be both with an inner cone and without an inner cone. This choice is determined by the proposed method of sealing the housing of cartridges in their equipment.

Sleeves without inner cone are designed for circular rolling of cartridges. The use of such sleeves for rolling multibeam star (rolling type “star”) does not allow to provide a stable shape, the minimum diameter of the central hole, increases the probability of deformation, crumpling, overlap of the rays of the star.

Sleeves with an inner cone are designed for rolling cartridges with a multibeam star. The use of such sleeves for circular rolling is possible, but does not allow to provide a stable shape and increases the probability of deformation of the rolling due to the crumpling of the conical part of the body.

Sleeves with a cardboard case differ in design from sleeves with a plastic case only in the material used, they can use a cardboard pallet. For a long period of time, before the advent of high-strength polymer materials, sleeves with a cardboard body were the main type of sleeves, but later they were replaced by sleeves with a polymer body. Now their production is resumed first of all for cartridges of 12 caliber. The main advantage of sleeves with cardboard body is temperature stability in a wide temperature range. However, despite the coating with a moisture-proof varnish, the cardboard case is exposed to moisture. Swelling of cardboard under the action of moisture can occur in conditions unacceptable for the storage of cartridges, causing at the same time also intense corrosion of the metal base of the sleeve and the primer-igniter.

Metal hunting cartridges are available in two types: the Central battle (OMC) and zhevelo (OMJ) — for equipment of cartridges of calibers 10, 12, 16, 20, 28, 32 produced in the USSR, now in the Russian Federation. The OMC inner anvil type cartridges are designed for use with Central battle primers for hunting rifle cartridges (CBOs). OMJ type sleeves without internal anvil are intended for use with primers-igniters “Zhevelo”.

The average resource of a metal sleeve should be at least 20 shots. In this case, such sleeves are subject to residual plastic deformation, in connection with which in most cases, after each shot, it is necessary to restore their shape with the help of a special mandrel. However, the main problem with the use of metal sleeves is the impossibility of using wads, obturators, gaskets and other auxiliary equipment elements intended for use in sleeves with a plastic body due to the difference in internal diameters. For example, the inner diameter of a 12 gauge metal sleeve is 19.3–19.4 mm, which is significantly larger than the inner diameter of a similar caliber sleeve with a polymer body.

Metal sleeves have no industrial application, are used in small quantities by hunters for equipment of cartridges in house conditions.

The materials used for the manufacture of all-stamped metal sleeves for rifled hand-held small arms are subject to requirements determined by the process of their manufacture and operation of cartridges (ammunition). Currently, it is established that the best in terms of compliance with the requirements are brass grades L68 and L70. However, we note the high cost of such cartridges, the tendency to corrosion changes, which complicates their long-term storage (requiring the duration of storage in a sealed metal seal, without loss of performance and a slight decrease in ballistic properties for at least 40 years — for cartridges for combat hand-held firearms). The interaction of alloy elements (brass) — copper and zinc with ammonia and mercury vapor, which are components of propellant charges and initiating substances of primers, leads to oxidation of the metal and the appearance of microcracks. In order to reduce the impact on the sleeve material, inert coatings (varnishing, phosphating, Nickel plating) are used.

At present, low-carbon steel grades 11UA and 18UA are recognized as cheaper and non-scarce material, not prone to external influences. However, the production of sleeves made of such material requires the use of wear-resistant tools, anti-corrosion and anti-friction coatings.

To simplify the technological process of manufacturing steel sleeves as a solid lubricant used tompak in the form of a double coating thickness of 4–6 % of the thickness of steel products. At the same time, it is quite difficult to maintain the continuity of tompak coating on the entire surface of the steel sheet, in connection with which the enterprises of the Russian Federation are now widely used varnishing cartridges of mass production, which simplifies the production cycle and reduces the cost.

The tendency to use polymeric materials in the production of cartridges (ammunition) can be traced in the production of cartridges for both civilian and military hand-held small arms, which is explained by the desire to reduce the mass of cartridges (ammunition), simplify the technological process and reduce the time-consuming costs for the production of cartridges of this type.

In particular, in the process of improving self-defense systems, which include traumatic pistols: PB-4 “WASP”, PB — 2 “WASP-aegis” and Mr — 461 “Guard” — developed cartridge 18×45T with a polymer sleeve [199]. The sleeve of this cartridge is assembled, produced by injection molding into a mold; the bottom part of the sleeve is made of stainless steel by stamping and is attached to the body of the sleeve by rolling. On the inner surface of the housing section of the sleeve are ready inclined rifling designed to stabilize the bullet rotation. At the moment of a shot the bullet at interaction with a rifled part of the case of a sleeve acquires rotational-translational movement, than stability of its flight on a trajectory is provided (figure 2.2.6).

a b

Figure 2.2.6 — **Cartridge 18×45T “A+A” with polymer sleeve:**
a — General view of the cartridges (left-rubberized throwing element);
b — scheme to ensure stabilization of the bullet cartridge flight
18×45 “A+A” [199]

For cartridges (ammunition) used for firing from combat hand-held small arms, sleeves made of polymeric materials are practically not used, since the physical and chemical properties of polymeric materials can vary depending on the ambient temperature, as well as heat dissipation when basing the cartridge (ammunition) in the chamber of automatic firearms to exclude self-ignition of the propellant charge. According to the military standards of the North Atlantic Treaty Organization (NATO), the propellant charge of a cartridge (ammunition) should not self-ignite when it is sent to the chamber of a hand-held small-arms firearm after a continuous production of 150 rounds [56, p. 207]. However, the American PCP Ammunition Company currently produces cartridges with a 5.56×45 NATO, 6.8×43 SPC, 7.62×51 NATO, 8.6×70 (.338 Lapua Magnum) and 12.7×99 NATO (.50 BMG), the casing of which is partially made of polymeric materials [197]. Испанская компания Extreme Polymer Research [196] developed a range of cartridges (ammunition) with a fully polymer sleeve, the operating temperature range of which is from –40 °C to +150 °C.

With regard to the expert study of cartridges (ammunition) used for firing small arms, it should be borne in mind that the use of polymeric materials as a material for the manufacture of cartridge cases can significantly complicate the process of identification research. As the expert practice shows, traces of weapon parts formed on polymeric materials as a result of preparatory, accompanying and completing shooting phenomena, processes and operations, although they have a set of identification features, as a rule, have a low contrast compared to the “background”, which complicates the process of photographing them without special preparatory techniques and operations to enhance the contrast of individual features of the traces on the object under study. Besides, high quality of processing of trace-forming elements of a design of modern samples of manual small arms considerably complicates detection of characteristic individual features that leads to impossibility of identification of a concrete copy of manual small arms from which the shot was made [97, pp. 74–80; 239].

Russian scientists N. Yu. Goryacheva, A.V. Fedin, V. A. Fedorenko, E. A. Chashchin proposed a method for applying mechanically or with a laser additional identifiers in the form of forensic labels (barcodes) on the details of hand-held small arms involved in the process of trace formation on the cartridge case (ammunition) in the production of the shot. The analysis of the results obtained during the experiments clearly shows that at present the presence of such marking significantly facilitates the process of forensic identification of civil and service small arms firearms by traces on the elements of cartridges (ammunition) [48, pp. 63–103; 268, pp. 56–58].

The sleeves of all industrially produced cartridges (ammunition) for rifled small arms allow their use in self-loading (automatic) weapons, while the speed of the cartridge into the chamber reaches in some cases a speed of about 10–15 m/s. Arising as a result of this process, inertial forces can destroy the housing of the cartridge (ammunition) and cause the cartridge to settle (premature exit of the bullet from the housing or the muzzle of the sleeve with a possible precipitation of the propellant charge). To eliminate this phenomenon, certain methods of fixing the bullet in the sleeve are used: tight fit (the bullet is held in the casing by friction); core (round or rectangular core); rolling the edge of the body (muzzle) of the sleeve into the annular groove of the bullet body; crimping the body (muzzle) of the sleeve into the annular groove; combined (combination of the above techniques) (figure 2.2.7).

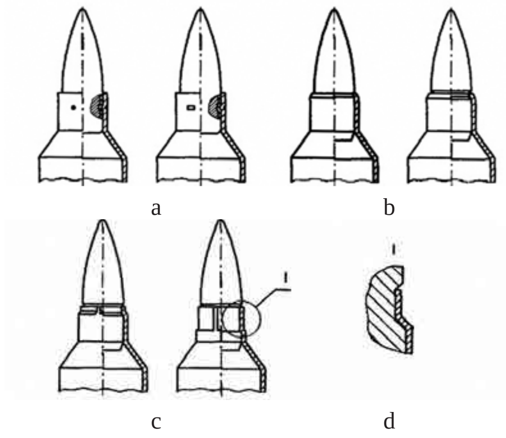


Figure **2.2.7 — Fixing the bullet in the cartridge case (ammunition):**
a — core gun muzzle; b — rolling the muzzle; c — muzzle crimp;
d — attachment fragment [54, p. 251]

The value of the bullet-extracting force in cartridges (ammunition) used in modern hand-held small arms is 190–1200 H [90, p. 201], which provides the necessary strength of the bullet attachment in the cartridge case, as well as the achievement of the required value of the forcing pressure.

Connection of elements of equipment of the cartridge (ammunition) to smoothbore hunting manual small arms in sleeves with the polymeric and cardboard case is provided by deformation of the case (rolling). The casings of hunting shotgun cartridges can be rolled by a multipath star (rolling "star") or circular rolling. This takes into account certain features.

First, multibeam star rolling cartridges must be of fixed length. A necessary condition for reducing the rays of the star in the center of the rolling with a minimum diameter of the Central hole is the deformation of the portion of the sleeve body of a strictly defined length, depending on the caliber. For example, for 12 gauge cartridges, the length of the deformable portion of the sleeve body is 11 mm, therefore, a 12/70 caliber cartridge should always have a length of about 59 mm, a 12/76 caliber cartridge should have a length of 65 mm, etc. Thus, the length of the deformable portion of the shell casing decreases with decreasing caliber of the cartridge.

Secondly, for the equipment of cartridges with multibeam star rolling in the industry, sleeves with an inner cone are used, which is a necessary condition for a stable rolling shape with a minimum diameter of the central hole. The use of sleeves without an inner cone is associated with an increase in the number of cartridges with various rolling deformations, overlapping of star beams, unstable diameter of the central hole. In addition, if the diameter of the central hole is unstable, it is possible to pour small fractions through the central hole.

Circular rolling cartridges have a limited maximum length. The maximum length of the cartridge is determined by the length of the deformable portion of the muzzle of the sleeve required for complete rolling. The length of the deformable section of the sleeve muzzle for complete rolling depends on the thickness of the sleeve body, on the caliber and is 5.0–5.5 mm. Thus, the maximum length of a 12/70 caliber cartridge should not exceed 64.5 mm, a 12/76 caliber cartridge should not exceed 70.5 mm, etc.

Circular rolling, made with defects, leads to a weakening of the cartridge design and significantly increases the probability of precipitation of the shot when hitting and dropping the cartridge, as well as as a result of the impact of inertial loads on the shot when firing multi-shotguns. The minimum length of cartridges with circular rolling has no clear restrictions and is determined only by the possible deformation of the rolled part of the sleeve body in case of excessive rolling depth. In most cases, there are no problems associated with circular rolling, with a rolling depth of up to 10 mm.

The small length of the deformable section of the sleeve body allows a significant increase in the length of large caliber cartridges. This causes an increase in the volume occupied by the fraction, and, accordingly, the mass of the fraction. The absence of strict restrictions on the minimum length of cartridges with circular rolling allows you to equip hunting cartridges (ammunition) caliber 12/70 shot weighing 32, 34, 36, 38, 40 and 42 g.

Devices for initiation of propellant charge (primer-igniter). To initiate the chemical transformation of the propellant charge of the cartridge (ammunition), initiation means (primers) are currently used, structurally representing a shell (cap) in which a substance or a mixture of substances sensitive to external impulses — shock, puncture, heating, friction [86, pp. 4–5].

Primers are designed to create a thermal pulse in the form of a beam of fire to communicate its propellant charge of the cartridge (ammunition). Caps-igniters must operate reliably from the impact of the striker, i.e. have sufficient sensitivity-the ability to operate from the impact of a certain force. At the same time caps-igniters have to be safe in the address, equipment and loading of manual small arms, have a certain flammable ability (power) rendering reliable monotonous influence on a propellant charge of a cartridge (ammunition). The primer-igniter must provide a beam of fire of a certain length, duration of action and strength. The length of the flame force, the duration of its action and the force are combined by the term "flame force", which is the defining characteristic of the primers. The best initiating ability is possessed by primers-igniters forming the greatest force of the flame.

Ignition of the propelling charge with primer-igniter is not instantaneous, and for some time. To ignite the powder charge, it is necessary to heat it to the appropriate temperature. The stronger the igniting impulse, the sooner the process proceeds. Black powder is ignited relatively easily. Smokeless gunpowder is more difficult to ignite and requires powerful means of initiation. At the same time, the greater the propellant charge, the more powerful the igniter is required for it. At independent equipment of cartridges to the smoothbore hunting firearms used in the conditions of low temperatures, hunters strengthen the primer-igniter with 5–6 grains of smoky powder that gives an increase of a force of a flame and improves Flammability of a propellant charge of smokeless powder.

A relatively weak primer igniter can cause a prolonged shot, i. e. a shot that does not occur immediately, but after a certain period of time after the strike of the striker on the cartridge's cap. In this case, the beam of fire ignites only the nearest layers of gunpowder, and further layers ignite from the first after a certain period of time. Such ignition can lead to local high pressures, and sometimes to rupture of the barrel of the weapon. This is all the more dangerous because the shot can occur after opening the gun.

The use of a more powerful primer-igniter can cause an increase in the initial velocity of the thrown element and an increase in the pressure in the channel of hand-held small arms, which can also lead to the above undesirable consequences. In this regard, usually try to avoid the use of cartridges (ammunition) as weak and overly powerful primers-igniters.

In cartridges (ammunition) to modern manual firearms, depending on the method of production of the shot from it, primers are used: 1) shock initiation; 2) electrical initiation (their design contains elements that convert electrical energy into heat).

In percussion initiation primers (the most common), the triggering mixture is triggered by the dynamic compression of the striker's striker on the anvil. The main composition used in the equipment of percussion caps-igniters is a mixture of explosive mercury (initiator), potassium chlorate (oxidizer) and antimony tri-sulfur (fuel) [86, pp. 13–14]. However, this mixture causes corrosion of the barrel of the weapon when fired, resulting in reduced resource weapons as a whole. In order to eliminate this disadvantage, initiating compositions that do not cause corrosion of the trunk were used, as initiators in which lead trinitroresorcinate or dinitrodiazophenol were used [54, p. 274]. In particular, the cartridge 5.45×18, used for shooting from a pistol self-loading, small-sized (PSM), used neorzhavlyayuschy capsule composition of the following composition: teneres (15 %), tetrazene (2 %), bertoletova salt (42 %), antimony sulfide (41 %) [57, p. 192].

Cartridge primer-igniter (figure 2.2.8) is a solid metal shell (cap), which is pressed into the composition, sensitive to impact. On top of the structure for protection from external influences is closed by a metal foil or parchment, sometimes the composition of the cover layer of varnish.

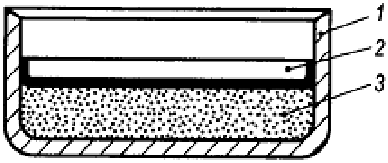


Figure 2.2.8 — **Scheme of the device of the primer-igniter "Berdan":**
1 — shell (cap); 2 — cover; 3 — impact

The shell (cap) is made most often of copper; it must have a strictly defined shape and size for the outer and inner diameters, height, and thickness of the walls and bottom. The shell (cap) must be made of a material that does not interact with the components of the shock composition, and must ensure the safety of the capsule during storage and use. When fired, the shell (cap) of the cartridge primer-igniter must remain intact and thus prevent the breakthrough of gases through its walls and bottom, as well as at the junction of the shell with the edges of the capsule socket (breakouts around the circumference). The bottom of the shell (cap) should not break through from the impact of the striker.

In addition, the shell (cap) should be tightly included in the capsule socket of the sleeve, and after the shot is somewhat distributed and tightly fit to its walls.

The shell (cap) of the cartridge primer-igniter (figure 2.2.8) is made by stamping from sheet metal. The shape and outer dimensions of the shell (cap) are determined by the shape and size of the capsule socket of the sleeve. The outer diameter of the shell (cap) and its height should be of such dimensions as to ensure a tight entry of the capsule into the capsule socket of the sleeve and to prevent both the dropout of the capsule from the sleeve and gas breakouts along the circumference. The thickness of the bottom and walls of the primer-igniter is determined by the pressure of the powder gases when fired and the force of impact of the striker of the weapon. In case of application of too thin shell, gas breakouts and penetration of the primer-igniter, as well as excessive sensitivity of the latter to impact, are possible. The thickening of the shell leads to a decrease in the sensitivity of the primer-igniter.

When striking the striker on the bottom of the primer-igniter, the shock (initiating) composition ignites, the beam of fire through the seed holes in the partition penetrates into the charging chamber of the sleeve, the powder ignites and the shot occurs. The sleeve itself serves as an obturator preventing the possibility of gas breakthrough to the gate. At a shot it is distributed, rests a bottom part in a gate mirror, densely adjoins walls of the case to chamber walls, thereby preventing break of gases towards a gate. The retention of gases from breaking through to the bolt through the firing holes is provided by the primer cap, which should sit tightly in the primer socket and remain intact when fired.

The inner diameter of the capsule shell is determined from the difference between the outer diameter and the thickness of the two walls. From the inner diameter and depth of the shell depends on the internal volume in which the charge of the shock composition is placed.

Currently, for the shells of cartridge primers, brass and copper are used in the form of thinly rolled tapes with certain mechanical properties that provide ease of manufacture of the shell, its strength and proper sensitivity of the capsule to impact. Too hard metal will prevent the striker from advancing and weaken its impact, which can reduce the sensitivity of the primer.

Shells for caps pistol, revolver and rifle cartridges are made of brass. Copper is used for the shells of hunting capsules. The use of iron for these purposes is more economical than other metals, but due to the rapid corrosion of iron in a humid atmosphere, iron shells are unsuitable for long-term storage. Attempts to use such shells for hunting primers were not successful, given the reduced sensitivity of the caps to the impact of the striker due to the hardness of iron.

To protect against corrosion, iron caps are plated with a layer of non-ferrous metal-tin, honey or zinc. Zinc coating is the most economical and at the same time has sufficient resistance. Copper shells are coated with a layer of tin (tinned) or Nickel-plated, and sometimes oxidized.

As coatings for the shock composition in cartridge primers, igniters use mugs of thin metal foil, and sometimes from vegetable parchment, the side of which, facing the shock composition, for better adhesion to it is varnished with shellac-rosin alcohol or nitrocellulose varnish. Vegetable parchment is used to reduce the sensitivity to the impact of some varieties of capsules, as well as in order to save. Paper circle varnished and on the outside. In some cases when using foil circles also varnish the joint of the mug with the inner walls of the cap. The total thickness of the coating, composition and bottom of the shell is called the height of the shock composition.

For military cartridge primers, igniters use mugs of thin foil made of pure tin with the addition of antimony (2–3 %) to give rigidity. Lead foil clad with a layer of tin is used for primers of cartridges for hunting hand-held small firearms.

Foil or paper circle should have a certain diameter and a certain thickness for each class of primers. The diameter of the foil mug is determined by the inner diameter of the cap, and the thickness of the foil is determined by the sensitivity of the primer to impact. With the thickening of the foil, the sensitivity to shock decreases, and Vice versa.

For the best fixing of shock structure an internal surface of a cap varnish. The installed suspension of the shock composition of a given formulation is pressed under a certain pressure.

The main element of the primer-igniter is the shock (initiating) composition, which must be sufficiently sensitive to impact and at the same time safe in the manufacture and handling of it. The flame force must be of sufficient power to ensure ignition and normal combustion of the propellant charge burning. In addition, the shock (initiating) composition must be resistant to storage and not to enter into chemical interaction with the metal shell and coating, and the combustion products of the shock (initiating) composition must not have a harmful effect on the material of the barrel of hand-held firearms.

The monotonous action of cartridge primers is provided by the monotony of the formulation used, the mass of the charge and the degree of compression of the shock composition.

Currently known initiating explosives in pure form are unsuitable for the equipment of primers, because they have a high sensitivity to impact and do not form a beam of fire necessary for the ignition of gunpowder. Being substances with significant high-explosive properties, they are characterized by short-term action.

Used for charges smokeless gunpowder require a strong and relatively long exposure to the flame. Therefore, along with the initiating explosives, as sensitive to impact, so-called *regulatory impurities* are introduced into the shock compositions, reducing the high-explosive action of the initiator and at the same time giving a sufficient beam of fire for ignition of gunpowder and other explosives.

As regulatory impurities are used primarily combustible substances, which during combustion emit the necessary amount of heat and create the required for ignition of gunpowder beam of fire. From combustible substances are selected such, the combustion of which remains a large number of solid particles. The particles hit the propellant charge, thus providing the strength and duration of the fire beam. Under similar conditions, a greater Flammability is possessed by the shock composition, which, when ignited, forms a greater number of solid particles heated to a high temperature. Solid particles, having a higher density compared to gases, contain a greater amount of heat per unit volume, and therefore are able to quickly heat the particles of the flammable substance to the ignition temperature.

In addition, as regulatory impurities used substances that reduce or increase the sensitivity of the composition — *phlegmatizers and sensitizers*; substances binding to individual components of the mixture — *cementators*, as well as substances that neutralize acidic decomposition products that can be formed during storage — *stabilizers*. For complete combustion of all elements of the composition, oxygen-rich substances — *oxidizers* — are introduced into it.

Thus, the impact composition is a mechanical mixture consisting of an initiating explosive, or initiator, and regulatory impurities containing fuel and an oxidizer as mandatory components. Phlegmatizers, sensitizers, cementators and stabilizers are not mandatory components and are introduced into formulations as needed. In capsule, the composition may be added substances, reducing the temperature of combustion shock structure.

The components of the shock composition must be taken in a certain ratio and with a certain amount of their crystals, and carefully mixed together to obtain as homogeneous a mixture as possible, since the sensitivity of the shock composition and its flammable ability depend on this.

When choosing the formulation of the composition in the production of primers, the following circumstances are taken into account:

1) the lower the brisance of the shock composition, the better its Flammability;

2) the greater the pressure created by the products of the explosion, and the higher the temperature of these products, the better the Flammability of the primer-igniter;

3) the least explosive shock compositions emit the greatest amount of heat and have the highest temperature of solid combustion products;

4) percussion compositions containing the largest amount of initiator have the greatest brisance;

5) the longer the flame beam of the primer-igniter formed by the shock composition, the more reliable the ignition of the propellant charge [86, p. 13].

Increasing the length of the beam fire of the primer-igniter is often hampered by the fact that the greatest length of beam fire give shock most blasting compositions containing the products of combustion, fewer particulates.

Currently, the shock compositions consist of a mixture of three components: bertolet salt ($KClO_3$), rattlesnake mercury ($Hg(CNS)_2$) and antimony sulfide (Sb_2S_3) in various ratios. In the shock composition, mercury is the initiator, potassium chlorate is the oxidizer, and antimony sulfide is the fuel.

Rattlesnake mercury and potassium chlorate are manufactured in factories, antimony sulfide is used exclusively of natural origin, occurring in nature in the form of an ore called antimony luster or antimonite [86, p. 13].

To increase sensitivity, finely ground glass and emery were sometimes added to the composition, and gelatin, shellac, gum arabic and artificial resins were added to reduce sensitivity and as cementators. Currently, shock compositions are prepared mainly without additives, greatly complicating the production process, avoid the use of glass in shock compositions, since it increases the danger in production [86, p. 14]. The sensitivity of the composition is changed depending on the degree of grinding of antimony sulfide-a solid with sharp-angled crystals. For each class of primers, both the percentage ratio and the size of the crystals (grains) of the components of the initiating mixture are established. To calculate the percentage of these components come from the reaction of their decomposition, but in practice it may vary depending on the purpose (type) of the primer-igniter.

Explosive mercury-chloride compositions with antimony sulfide are sufficiently sensitive to shock and heat, safe in manufacture, give the necessary flame beam for ignition and safe in storage. The main drawback of these compositions is that they have the ability to interact with some metals, and the products of their combustion act both on the barrel of a hand firearm and on the cartridge case. The effect of chlorate compounds on the metal of the barrel of the weapon was noticed in the first period of the appearance of primers: the barrels of capsule guns required more care than the barrels of flintlocks. The survivability of the barrels of hand held small arms has especially deteriorated with the beginning of the use of smokeless gunpowder for shooting.

A detailed study of this phenomenon showed that the deterioration of the survivability of weapons is the result of the harmful effects not only of the combustion products of smokeless powder, but also of the combustion products of the percussion cap composition burning. When firing smoky gunpowder, this phenomenon was weakened, since the carbon of smoky gunpowder reduced the harmful effect of the combustion products of the capsule composition, partially neutralizing them.

Combustion products of smokeless powder are not able to neutralize the combustion products of capsule compositions burning. In addition, the ignition of smokeless gunpowder required a more powerful primer composition than for smoky, which significantly increased the effect of combustion products on the bore of the weapon [86, p. 15].

The decomposition reaction of greatertoronto impact of the structure can be represented in the following equations:

$$3Hg(CNO)_2 + 2KClO_3 \rightarrow 3Hg + 3N_2 + 2KCl + 6CO_2\,;$$

$$3KClO_3 + Sb_2S_3 \rightarrow 3KCl + Sb_2O_3 + 3SO_2.$$

Summing up, we get:

$$3Hg(CNO)_2 + 5KClO_3 + Sb_2S_3 \rightarrow 3Hg + 3N_2 + 5KCl + 6CO_2 + \\ +3SO_3 + Sb_2O_3.$$

It follows from the above equation that the combustion of the shock composition produces both gaseous and solid products. Gaseous products do not have a great harmful effect on the weapon, because they are carried away from the barrel along with the powder gases and their effect is short-lived [86, pp. 15–16].

The greatest impact on the bore of small arms has the effect of solid reaction products. Solid products of antimony oxide and potassium chloride partially in the form of slags settle on the walls of the trunk. The metal of the barrel is fused with the hot slag of the impact composition and becomes fusible. Molten metal particles are carried away by gunpowder gases, in connection with which shells and potholes are formed in the barrel channel, which are formed mainly near the chamber and the bullet entrance. In addition, potassium chloride particles are burnt to the walls of the trunk and due to its hygroscopicity gradually absorb moisture. As a result, potassium chloride is partially dissolved and dissociates into potassium and chlorine ions, which, acting catalytically, causes intense oxidation of iron, and the bore is covered with corrosion products.

Harmful effects are also produced by the combustion of the shock composition of vaporous metallic mercury, which is removed from the firing of the barrel is not completely and partially condensed in the cold part of it in the form of drops. In the barrel channel mercury forms an amalgam, making it difficult for the bullet to pass through the rifling. This leads to leaded bore, which increases over time, and the weapon loses its combat qualities. In addition, mercury amalgamates brass and copper sleeves, causing them to crack.

Combustion products of capsule compositions, in addition to chemical effects, destroy the bore of weapons and purely mechanical way. The combustion of the bore near the chamber is mainly due to the temperature of the capsule slag and a significant rate of departure of these particles into the barrel. As the flame temperature increases, the degree of softening of the barrel metal increases, and thus the introduction of solid particles into it is facilitated, since with an increase in the speed of flight, the particles penetrate deeper into the metal. The greater the content in the impact composition of rattlesnake mercury, the greater its brisance and the rate of decomposition, solid particles with greater force hit the surface of the barrel. There is a “bombardment” of metal, which at a high flame temperature leads to the burning of the trunk and the formation of shells and potholes in it.

Table 2.2.1 — **Formulation of rattlesnake percussion compositions, %**

Primer-igniter	**$Hg(CNO)_2$**	**$KClO_3$**	**Sb_2S_3**
Cartridge 7,62×39R “Nagan”	25	37.5	37.5
Cartridge 7,62×54R	16	55.5	28.5
Cartridges (Germ.) 9×19 Para, 7,92×58	22.5	40	37.5
Cartridge 5,6×16R	50	30	20
Chew	50	30	20

To avoid the harmful effects of combustion products of shock compositions on the barrels of small arms, chemists have proposed a large number of shock compositions that do not have a destructive effect on the metal barrel. Such compositions are called “non-corroding”, “anti-corrosive” or simply “non-rusting”.

Non-corroding compounds began to be actively investigated in the early XX century. Initially, the research was reduced to the replacement of potassium chlorate with another oxidizer that does not contain chlorine. In 1900, it was proposed to replace potassium chlorate with barium nitrate $Ba(NO_3)_2$ with the addition of barium carbonate $BaCO_2$ to neutralize the acidic reaction products. Later, a number of nitro compounds were added to barium nitrate, reducing the content of antimony sulfide in the shock composition and increasing the content of rattlesnake mercury. Of the nitro compounds, picric acid was first used, and then it was successively replaced with TNT, potassium picrate, tetrile, etc.

In addition to barium nitrate, chromic acid salts of various metals (chromates), mainly lead and mercury, were also recommended as oxidants. At the same time, it was suggested that after combustion of the composition, metal oxides, including chromium oxide, will be deposited on the walls of the barrel, forming a protective film that protects it from corrosion. To enhance the Flammability of these compositions added to the lead dioxide, the dioxide of barium and silicon calcium.

As combustible, in addition to antimony sulfide and other substances already mentioned above, lead rhodanide began to be used $Pb(CNS)_2$ and calcium siliceous ($CaSi_2$).

When replacing potassium chlorate with another oxidizer, shock compositions were obtained that did not cause rusting of the weapon, but did not eliminate the mechanical destruction of the metal near the chamber from impacts and the thermal action of solid particles, so when developing non-corroding compositions, mercury began to be replaced by other initiators.

Initially, it was proposed to use instead of rattlesnake mercury rather sensitive to the impact of sulfur nitrogen, but shock compositions with this substance were unsuitable due to its high brisance. The later proposed red phosphorus and picrates also did not spread due to the instability of the former during storage and the weak flammable ability of the latter.

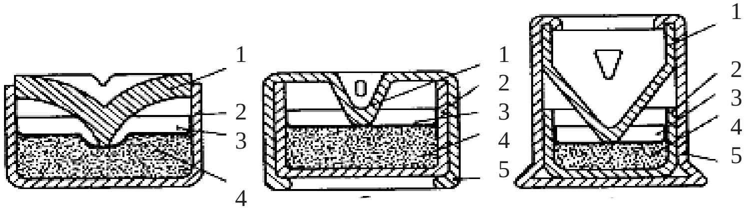
In the future, instead of rattlesnake mercury began to use the main lead salt of trinitroresorcinol and normal, known as TNRS (lead trinitroresorcinate). Subsequent studies have shown that the best are shock compositions containing tetrazene and TNRS.

Tetrazene is a substance that is very sensitive to impact, but it does not have a strong enough flammable ability in relation to the rest of the composition. TNRS is also a good igniter, but its sensitivity to impact is weaker. When mixed, both components have both sufficient sensitivity to shock and reliable Flammability. As an oxidizer, barium nitrate, or nitric acid lead, is added to them, and antimony sulfide or lead rhodanide is added as a fuel.

Table 2.2.2 — **Formulation of some non-rusting percussion compositions**

Components	Content (%)								
Mercury fulminate	35	30	50	40	30	–	–	–	–
TNRS	–	–	–	–	–	40	–	40	40
Tetrazene	–	–	–	–	15	1	3	–	2
Diazodinitrophenol	–	–	–	–	–	4	37	–	–
Barium nitrate	25	35	30	46	–	–	–	35	–
Bertoletov salt	–	–	–	–	25	–	–	–	–
The lead dioxide	35	–	–	–	–	–	–	5	–
Barium carbonate	–	6	–	–	–	–	–	–	–
Tetryl	–	–	–	5	–	–	–	–	–
Antimony sulfide	15	25	20	9	30	–	–	–	–
Glass	–	4	–	–	–	19	19	–	20
The thiocyanate lead	–	–	–	–	–	7	7	–	8
Lead nitrate	–	–	–	–	–	29	34	–	30
Calcium silicide	–	–	–	–	–	–	–	20	–

Currently, two types of primers are used to equip cartridges: without an anvil (open type) (figure 2.2.8) and with its own anvil (closed type) (figure 2.2.9).



a) b) c)

Figure 2.2.9 — **The scheme of caps-igniters with an anvil:**
a — capsule “Boxer”; b — the capsule of Nordenfeld;
c — the capsule “Revelo”; 1 — anvil; 2 — cup; 3 — cover;
4 — the shot composition; 5 — shell

The Berdan igniter capsule (figure 2.2.8) was invented by U. S. army Colonel Hiram Berdan in 1866 and is a metal cap with a shock-igniter composition covered with a foil tin circle. The material of the cap — copper (brass, tombac) with varnished or Nickel-plated or steel with oxide coating. Cartridge cases when using primers of this type are made with a projection of the anvil in the center of the capsule socket and two (one) ignition holes. “Berdan” is the main primer-igniter used in cartridges of Western European manufacturers.

The primer-igniter “boxer” (figure 2.2.9 a) was invented by the English Colonel E. boxer in 1961. It is a metal cap with a shock-igniting composition and an anvil in the form of a two- or three-petalled cone. Primers of this type are used in sleeves with a single ignition hole in the center of the capsule socket to facilitate the re-discharge of cartridges, are the main primers in the United States.

The “Gevelo “primer (figure 2.2.9 b) was originally used in the Pot-Schneider hunting cartridge (France) in 1861In its modern form it was released at the end of the XIX century by a French firm Gevelot. The primer-igniter has a brass shell (body) in the form of a sleeve with a protruding flange, at the bottom of which a primer-igniter of the Berdan type is placed, containing a shock-igniting composition, is held by an anvil inserted into the sleeve. The anvil is located on the shoulder pads available in the sleeve and is kept from falling out by the rolled edges of the sleeve.

Russian industry produces the following types of primers: “Zhevelo-M” — gremuchertutny; “Zhevelo-M” — powerful, “Zhevelo-N” (NG) — non-rusting (GOST 24579-81); KVM-3 (KVM-3M) — military.

Primer-igniter “Winchester” appeared in the 70s of the XX century. and in a short period of time became one of the main. Outwardly resembles a primer-igniter “Zhevelo”, but has differences: the body (sleeve) is open from the bottom part, where a small primer-igniter with an anvil is placed with the help of a press fit, the ignition hole of a smaller diameter is usually sealed with varnish. Thanks to the new design, the inertial stability is increased, which protects against accidental actuation, the probability of anvil departure is eliminated and the calibration of the fire beam is provided when passing the ignition hole of the normalized constant cross-section. Winchester primers are manufactured in the Russian Federation under the name KV-21 for sleeves with a seat diameter of 5.6 mm and KV-22 (KV-209) for sleeves of the European standard with a seat diameter of 6.2 mm.

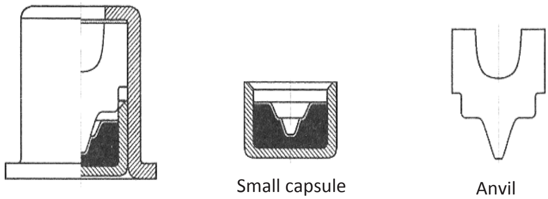
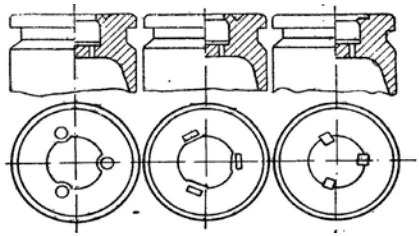
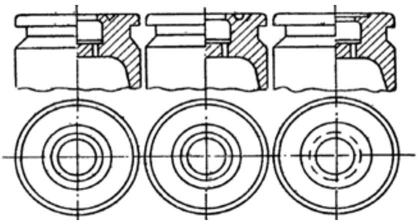


Figure 2.2.10 — **The system of the primer-igniter KV-21**



a



b

Figure 2.2.11 — **Attachment of the primer-igniter in the cartridge case:**
a — core in three points; b — core around the circumference
of the capsule socket

Fastening of the primer-igniter in the capsule socket of the sleeve is carried out, as a rule, by the method of tight fit (with tension), core at three points and around the circumference of the capsule socket. This provides the possibility of trouble-free operation of cartridges (ammunition) in self-loading and automatic manual small arms (figure 2.2.11).

The design of electric primers contains elements that convert electrical energy into heat. Currently, cartridges (ammunition) are used electric primers-igniters of two types.

The first type includes bridge caps-igniters (electric incandescent igniters). The design of these devices includes an incandescent bridge (made of nichrome, platinum-iridium or Melchior wire having a high resistivity) immersed in the initiating mixture of substances. When applying an electric current of a certain magnitude, the metal thread, heating to the required temperature, causes ignition of the initiating composition (electric igniters EVN-01M1, EKM-1A/80 and EKM-1A/190) used in cartridges (ammunition) of traumatic weapons of caliber 18×45T and 18×55T [298]. As the initiating composition of electric igniters with "incandescent bridge" at the enterprises of the Russian Federation, the following composition is used: potassium chlorate (49.5 %), lead rhodanide (49.5 %) and lead plumb (1 %) [28, p. 139]. It is also possible to use a different formulation of compositions, for example: lead rhodanide (40–60 %), potassium perchlorate (35–55 %), lead chromate (7–30 %), polymer binder (0.1–2 over 100 %) [299].

The second type of electric primers-igniters-electric igniters with conductive composition (conductive additives-coal, powdered metals are introduced into the mixture of the initiating composition). The passage of an electric current through the mixture causes local heating of the mixture of the initiating composition and its ignition. This type of electric igniters is used in the designs of caseless cartridges (ammunition) 4.7×33 to the G11 assault rifle of Heckler & Koch and 5.7×27 UCC to the vec-91 hunting rifle of Voere [56, pp. 205–208]. In cartridges (ammunition) 18×45T and 18×55T to traumatic weapons are mainly used electric igniters with "incandescent bridge" (EVN-01M1, EKM-1A/80 and EKM-1A/190). Compared with percussion-type primers, electric igniters have such an undeniable advantage as speed [22, pp. 29–30].

In addition, compared with percussion-type primers, electric igniters have such an undeniable advantage as speed. This is confirmed by the data of the comparative table below, which reflects the ratio of the time of speed of the weapon with manual firing control when using percussion and electric ignition primers in cartridges (ammunition), as well as various types of triggers. The delay time in the "man — weapon" system begins from the moment the shooter makes a decision on the production of the shot and ends with the moment of departure of the projectile from the barrel channel. This parameter is defined by the formula:

$$t_{\text{delay time}} = t_1 + t_2 + t_3 + t_4,$$

where t_1 — the reaction delay time;
t_2 — the response time of the trigger;
t_3 — the time of operation of the shock mechanism;

t_4 — the time from the beginning of ignition of the propellant charge until the departure of the projectile from the bore [22, pp. 29–30].

Table 2.2.3 — **The ratio of the time delay of the shot depending on the type of ignition of the propellant charge** [22, pp. 29–30]

Type of the trigger	The lag time of the shot. $t_{зап}$. sec	Component of the time delay. sec			
		t_1	t_2	t_3	t_4
Mechanical	0.19…0.30	0.04…0.06	0.11…0.18	0.006…0.01	0.030…0.045
Electromechanical	0.17…0.29	0.04…0.06	0.09…0.17	0.006…0.01	0.030…0.045
Electric	0.08…0.11	0.04…0.06	0.005…0.006	–	0.030…0.045

Thus, the analysis of the data given in table 2.2.3 allows to draw the following conclusions about the advantages of electric ignition:

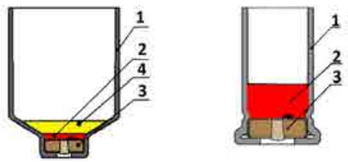
1) this type of ignition is the most rapid-acting type of initiation of the propellant charge, capable of providing maximum speed of use of weapons;

2) the absence of mechanically connected parts in the electric ignition system and the ability to regulate the trigger force within a wide range allow to reduce the fluctuations of the weapon at the time of manufacturing, aiming and firing, thereby increasing the probability of hitting the target.

Application of electric igniters in cartridges of the traumatic weapon of caliber 18×45T and 18×55T contributed to a significant increase in the reliability and efficiency of the complex "weapon — cartridge". It is noted that the introduction of microprocessor control of electric igniters cartridges virtually eliminated the possibility of delay in firing, and the replacement of the cartridge in the design of the gunpowder charge increased linkage of the initiating composition had a positive impact on the stability of the striking properties of the throwing element. The spread of bullet velocity when firing these cartridges was ±10 m/s [262], it was unattainable when used as a propellant charge pyroxylic gunpowder.

The use of the design of cartridges (ammunition) small firearms of the electric igniter makes it impossible to identify a specific instance of small firearms in the classical sense (on the trail of a striker on the percussion cap of the igniter). However, the use of forensic and ballistic tests of cartridges (ammunition) 18×45T and 18×55T to the traumatic weapon shows that the solution to this problem is possible by researching the marks on the case and the base of the cartridge formed by locking the cartridges when loading (or unloading) as well as traces of contact groups gun [112, pp. 320–329].

Schemes of the internal device of the main types of electric igniters (EVN-01 M 1, KM-1A/80 and KM-1A/190) are presented in the figure 2.2.12. The difference between the electric igniter EVN-01M1 from the other two mentioned is that in their design, instead of a powder charge, an increased hitch of the initiating composition is used, which, burning more intensively than gunpowder, allows you to create the necessary discharge pressure in the cartridge case, informing the thrown element the necessary kinetic energy (80 J). The impossibility of obtaining stable ballistic characteristics of the cartridge 18×45T is explained by the fact that in a barreled traumatic firearm, the projectile receives acceleration and directional movement on the section of the cartridge case (ammunition) with a length of about two calibers (figure 2.2.12 b), as a result of which it becomes impossible to provide a stable value of the combustion rate of the propellant charge and achieve the necessary pressure in the discharge space [112, pp. 320–329; 113; 114; 298].



a b

Figure 2.2.12 — **The system of the electric igniter cartridges to the traumatic weapon:** a — EVN-01 M 1; b — KM-1A/80 (KM-1A/190); 1 — body, 2 — the triggering composition, 3 — washer with filament bridge, 4 — propellant charge [298]

The refusal to use the powder propellant charge in the design of the cartridge (munition) under consideration and the use of the pyrotechnic composition of the electric igniter as an energy source allowed to eliminate this drawback. The burning pyrotechnic composition exceeds the burning rate of pyroxylic gunpowder several times, which made it possible to achieve the necessary level of gas pressure on the projectile in a relatively short section of the shell casing cartridge (ammunition), which performs the function of the barrel in it. The kinetic energy of the projectile element (bullet) of such a cartridge is sufficient to defeat the target and is 80–90 J.

A similar principle is used in Flaubert cartridges, in which the propellant charge is absent, and its functions are performed by the impact pyrotechnic composition [113; 114] (figure 2.2.13).

a b c

Figure 2.2.13 — **Device doorsteps of Flaubert's cartridges of caliber of 5,6 mm (.22 Cap) and 4 mm:** a — the internal structure of the cartridge, b — cartridges Flaubert caliber 5.6 mm (.22 Cap), c — 4 mm Flaubert cartridges

As it was noted above, earlier operating Technique of criminalistic research of cartridges (2008) did not allow to carry a cartridge of Flaubert to category "ammunition" as the propellant powder charge in a design of this cartridge is absent, and its functions are carried out by shock pyrotechnic structure [163]. At the same time practice of expert research of such objects testifies that the power characteristic of the thrown element of such cartridges can exceed the threshold of the minimum specific kinetic energy of the thrown element established in forensic ballistics (0,5 J/mm^2) even at factory value of a hinge of pyrotechnic structure in a sleeve; in addition, these cartridges are easily subjected to overvoltage homemade way, which allows you to significantly increase the damaging properties of the throwing element [114; 305]. Thus, we can agree with the position of S. V. Yatsenko, who believes that the absence of a propellant charge (as an energy source) in the design of cartridges is not the basis for their exclusion from the category of ammunition [303, p. 168]. We believe that in this case, the determining criterion for assigning such a cartridge to the category of ammunition will be sufficient to defeat the target value of the kinetic energy of the thrown element [129; 137; 142].

Propellant charge. As a propellant charge in the cartridges (ammunition) of hand-held small arms, both smoothbore and rifled, smokeless gunpowder is currently used. (Smoky gunpowder is used in isolated cases in cartridges of homemade equipment for hunting smoothbore hand-held firearms, signal cartridges). Gunpowder as an energy source has been used in hand held small arms since its inception. The main advantage of smokeless powder is relatively easy ignition of burning in parallel layers, which allows you to control the shooting process [55, pp. 264–271]. Currently, many types of gunpowder are known, but many of them do not meet the requirements, which is why practical application in the design of cartridges (ammunition) has not been found.

One of the main ballistic requirements on propellants are making the shot given the speed of the throwing element when installed technical specifications level maximum pressure in the barrel of a small firearm, and to ensure permissible deviation parameters initial velocities of methane element from the average value. In accordance with GOST 23128-78 "hunting Cartridges for rifled weapons" the average deviation of the bullet velocity in cartridges (ammunition) of factory manufacture from the average values when fired is set to no more than 15 m/s [7; 201, p. 5].

In cartridges (ammunition) used for shooting from hand-held small arms, pyroxylic gunpowder on a volatile solvent and lacquer gunpowder made of nitrocellulose varnish are used. Improvement of gunpowder is reduced to obtaining the most favorable ballistic characteristics by changing the methods of production of gunpowder, the introduction of various additives that improve both ballistic and operational properties. Depending on the number of high-energy components included in the powder, there are: a) single-base (without high-energy additives); b) dibasic (with the addition of one substance) and c) tribasic gunpowder (with the addition of two substances) [34, pp. 506–508; 54, pp. 264–271; 250, pp. 121–128; 264, pp. 189–196]. As high-energy additives used nitroglycerin, diethylene glycol dinitrate, hexogen, octogen [54, pp. 264–271; 291, pp. 273–275]. Experts point out that the cartridges of hand-held small arms are used mainly one-and two-basic types of gunpowder, while it is allowed to mix several types of gunpowder to obtain the necessary ballistic characteristics of cartridges (ammunition) [54, pp. 264–271].

Pyroxylin dibasic gunpowder, used to equip cartridges for smoothbore hand-held small arms, is a powder based on pyroxylin with the addition of nitroglycerin. Such gunpowder provides a higher temperature stability of the ballistic characteristics of the shot compared to single-base gunpowder due to the higher Flammability of nitroglycerin. To the greatest extent the advantages of dibasic powders are manifested in low temperature conditions.

Depending on the production technology, powder elements can have a plate, granular or cylindrical shape.

Plate powder elements are thin plates of round, square or diamond shape. Diameter or side plates for most gunpowder — 1.0–2.5 mm; thickness — 0.15–0.40 mm.

Granular powder elements are granules of different shapes and different fractional composition. Gunpowder in the form of granules spherical or close to spherical shape is called spherical gunpowder.

Cylindrical powder elements are cylinders or cylinders with a Central channel. The diameter of the cylinder for the majority of powders is 0.5–1.0 mm, length 1-5 mm; the diameter of the Central channel is 0.1–0.2 mm.

The greatest distribution for equipment of cartridges for shotguns got single base powders with plate-like shape of the powder elements due to the low cost of their production. The shape and size of the powder elements are optimized for the conditions of combustion of the propellant charge in cartridges for smoothbore hand held small arms. At the same time, all monobasic gunpowder contain 96–98 % pyroxylin and have almost the same chemical composition. The chemical composition of dibasic powders of different manufacturers also has no significant differences. Therefore, the difference in the characteristics of gunpowder is not related to their chemical composition.

The main differences in the characteristics of gunpowder associated with the density of gunpowder. Production technologies allow to produce gunpowder with a density of approximately 300 to 1000 g/dm^3. In turn, the density of gunpowder is determined by its porosity. The porosity of the powder elements, i. e., the presence in the powder elements of microscopic voids that increase the surface and rate of combustion, identifies all the main ballistic characteristics. Thus, the powder with high porosity and correspondingly low density has a high burning rate (quickmatch gunpowder), and gunpowder with a low porosity and a correspondingly high density has a low burning rate (melanogenesis gunpowder).

An important characteristic of gunpowder along with the density is its bulk density, which characterizes the mass of gunpowder in a fixed volume. The bulk density of gunpowder is determined by the density of the gunpowder, as well as the size and shape of the powder particles. Thus, depending on the bulk density of gunpowder with the same mass can occupy a different volume in the cartridge case.

Gunpowder of different brands with the same form of gunpowder elements have no visible differences, but many manufacturers tinted gunpowder for visual identification of the brand of gunpowder.

To give the powder the required flowability and eliminate the tendency to electrification, sticking of powder elements and sticking of powder elements on the components and parts of the equipment, the powder can be subjected to graphitization. Gunpowder elements of graphite gunpowder acquire a gray color.

When choosing gunpowder, the following regularities are taken into account:

the characteristics of gunpowder for ammunition of a specific caliber is determined by the mass of the methane equipment. Reducing the mass of the equipment thrown requires the use of gunpowder with a higher combustion rate burning;

the characteristics of gunpowder for cartridges of different calibers are determined by the size of the caliber. Reducing the caliber and the associated reduction in the volume occupied by the gunpowder requires the use of gunpowder at a lower rate of burning.

From the specified conclusion follows about impossibility of use of one brand of gunpowder for equipment of cartridges (ammunition) of various caliber, with various weight of the thrown equipment.

Hunting smokeless gunpowder “Sokol”, intended for use in cartridges (ammunition) for smoothbore hunting and sports hand-held firearms, is produced for a long time and is a single-base plate gunpowder with high density and low speed burning. This gunpowder is a universal gunpowder with compromise properties and provides acceptable ballistic characteristics of cartridges of 12, 16 and 20 calibers when using a variety of auxiliary elements of equipment, including cardboard, felt, wood-fiber and polymer wads and gaskets. Moreover, under designing gunpowder “Sokol” one of tasks was ensuring security patrons, kitted out hunters in household conditions, including low sensitivity shot being fired to excess masses gunpowder. Note that this gunpowder does not meet modern requirements and does not provide the necessary functional characteristics of cartridges, so it is practically not used in industrial equipment.

For each brand of gunpowder manufacturers provide recommendations on the choice of the mass of gunpowder when used in cartridges of different calibers, with different weight of the thrown equipment, and in some cases for different types of thrown equipment (lead shot, steel shot, bullet, etc.). To the greatest extent gunpowder adapted for use in cartridges for smoothbore hunting hand-held firearms caliber 12/70. All manufacturers offer brands of gunpowder intended for equipment of the most popular hunting and sports cartridges of caliber 12/70 with weight of lead shot of 24, 28, 32 and 34–36 g.

The results of ballistic tests of cartridges can be chosen powder with optimum characteristics for equipment of cartridges of other calibers, with different mass and other types of throwing equipment.

The approximate ratio between the mass of the propellant charge of gunpowder brand "Sokol" and the mass of lead shot for hunting cartridges of different calibers with a sleeve length of 70 mm are given in the table 2.2.4.

Table 2.2.4 — **Table of the ratio of the mass of shot and gunpowder at independent equipment**

Caliber and weight of the gun, kg	The type of wad	The charge of gunpowder "Sokol" at a temperature of		Projectile fractions, g
		+ 20 °C	– 20 °C	
12 3.2–3.5	W F C	2.3 2.2 2.0	– 2.3 –	32–36
12 2.8–3.1	W F C	2.2 2.1 1.9	– 2.2 –	30–32
16 3.0–3.2	W F C	2.1 2.0 1.8	– 2.1 –	30–32
16 2.7–2.9	W F C	1.9 1.8 1.6	– 1.9 –	27–29
20 2.6–3.1	W F C	1.7 1.6 1.4	– 1.7 –	26–31
20 2.4–2.5	W F C	1.6 1.5 1.3	– 1.6 –	24–26

Note. Wads: W — wood-fiber, F — felt osalenny, C — polyethylene container.

For dibasic gunpowder the ratio between the density of gunpowder and the mass of the thrown equipment may be different.

An important requirement for gunpowder, determining their suitability for practical use, is sufficient resistance, i. e. the ability for a long time to maintain unchanged their physical and chemical, and therefore ballistic properties. The analysis of works on operation of cartridges (ammunition) to fighting (military) rifled manual small arms testifies that term of the safe (without change of physical and chemical properties) the smoke-free gunpowder stabilized with diphenylamine over 20 years, unstabilized — 10 years; the useful life of gunpowder in cartridges (ammunition) outside the factory capping is one and a half to two times less due to the loss of their ballistic properties due to adverse storage and operation conditions. In military science the guaranteed period of storage of cartridges (ammunition) is considered to be 40 years as on expiry of such period occurs degradation of the propellant charge cartridge (ammunition), resulting in increases the speed of throwing item, and the gas pressure [7; 83, pp. 23–24].

Experimental shooting of cartridges (ammunition) 7,92×58 of factory manufacture (1936–1939 of manufacture), carried out in 2002 by D. A. Burya, showed that under elementary storage conditions, the change in the speed of the thrown element from the normative established by the technical documentation was 1–5 m/s. On the basis of the results of this experiment, the scientist made a reasonable conclusion that the striking ability of the projectile element of the cartridge (ammunition) of factory manufacture, due to the presence of stabilizers in the powder charge, provides stable ballistic qualities and the necessary level of striking ability even with significant shelf life [31, pp. 53–55].

In forensic ballistic examination of cartridges (ammunition), handheld small arms, barrel gas weapons, traumatic weapons combustion products of propellant and capsule composition are involved in the formation of additional traces of the shot, allowing to determine the firing distance, as well as with a certain probability to determine the person who fired the shot. This issue is fully covered in the special forensic literature [43; 153; 167].

At the same time it is important to pay attention that according to provisions of earlier operating Technique of criminalistic research of cartridges [163] research of physical and chemical properties of gunpowder in the course of forensic ballistic research of cartridges (ammunition) of manual small arms is not included in competence of the expert ballista, its actual existence as a design element is stated only.

Throwing element. According to paragraph 473 of GOST USSR 28653-90 “small Arms. Terms and Definitions” a Throwable element is understood to be ‟a part of a small arms cartridge intended to hit targets... that is thrown when fired from a barrel bore” [190]. From this definition it follows that the element of the design of the cartridge (ammunition), providing its main purpose — the direct defeat of the target, is the throwing element.

The movement of the bullet on the trajectory is considered as the movement of the body of rotation in the flow of gas or liquid.

The main ballistic characteristics of the bullet are: weight, manufacturing accuracy; ballistic properties, aerodynamic properties, stabilization, striking properties.

As a result of the development of science and technology by the 1970s, the shape, size, weight and design features of bullets used in cartridges (ammunition) of rifled small-arms firearms were developed and theoretically substantiated. To this time were implemented amp; d patrons (ammunition) with metaemym element of reduced caliber 5.56 mm — in countries NATO and caliber 5.45 mm — in the USSR [56, pp. 90–126; 57, pp. 692–708; 58, p. 5]. A certain technical limit was reached in the field of creating samples of hand-held small arms, since the developed samples of hand-held small arms had all the necessary tactical and technical characteristics. However, the cartridges (ammunition) used for firing in these samples did not fully meet the requirements.

Since the 1970s, the main directions of improvement of the projectile element of cartridges (ammunition) of hand-held small firearms have been reduced to the following: 1) improvement of ballistic properties of the thrown element on the trajectory; 2) development of bullets with the necessary damaging effect; 3) development of projectile elements of cartridges (ammunition) for use in certain conditions (under water, with subsonic bullet speed, on Board aircraft, etc.).

The mass of the bullet is determined by a combination of shaped and dimensional characteristics, as well as the properties of the materials used to manufacture its elements. The most important is the relationship between the mass of the bullet and its outer diameter. Depending on the outer diameter used in cartridges (ammunition) bullets are divided into:

caliber — with an outer diameter equal to or close to the diameter of the bore (caliber bullets). The peculiarity of this type of bullets is the ability to achieve a high mass;

subcaliber — bullets with an outer diameter substantially smaller than the bore diameter. Designed to be placed in a container that can be integral or composite. The composite container is an annular element (pallet) and located between the outer surface of the bullet and the inner surface of the sleeve of individual sectors (segments). After departure from the bore elements of the composite container are separated from the bullet under the influence of the incoming air flow. The peculiarity of sub caliber bullets is the ability to achieve a low mass of the bullet and a higher flight speed on the trajectory.

The mass of the bullet and the initial velocity of the bullet should be considered as two interrelated and at the same time contradictory characteristics of the bullet cartridge. Reducing the mass of the bullet provides the ability to increase the initial velocity of the bullet and Vice versa. To achieve the maximum initial kinetic energy of the bullet requires a decrease in mass and an increase in initial velocity. However, the achievement of maximum initial kinetic energy does not guarantee the achievement of maximum kinetic energy at a given firing range, since the ballistic properties of the thrown element depend on its mass, diameter and speed, and aerodynamic properties depend on the shape and speed.

Maximum firing range describes the maximum range at which an effective defeat of the target is possible. The maximum range is determined by the mass of the bullet and its initial velocity, size, ballistic and aerodynamic properties. The greatest impact on the maximum range of fire has a bullet mass. Light bullets of small calibers are characterized by a short range. In this case, the maximum firing range is limited not only by the value of the kinetic energy of the bullet on the trajectory, but also by the lowering of the trajectory.

High accuracy of bullet manufacturing is a necessary condition for straightness of bullet trajectory and high shooting accuracy.

The accuracy of manufacturing a bullet, considered as a body of rotation, is characterized by the eccentricity of the center of mass, i. e. the distance between the center of mass of the bullet (the point of application of gravity) and the longitudinal axis of the bullet. Ideally, the eccentricity of the center of mass is located on the longitudinal axis of the bullet (center of mass is zero). In the real case, the eccentricity of the center of mass is always greater than zero, with the result that the forces acting on the bullet on the trajectory are systematically applied to the bullet not symmetrically with the corresponding curvature of the trajectory. This is largely characteristic of three-element (surrogate) steel-core bullets to rifled hand-held small-arms firearms. The processes that occur with such bullets at the time of firing will be described in detail in section 3.4 of Chapter 3.

The accuracy of the bullet is determined solely by the manufacturing technology. Improving the accuracy of the bullet requires the use of a number of technological techniques. In cartridges (ammunition) for smoothbore hunting hand-held small arms, pores and voids in the body of a lead bullet arising in the casting process can cause a significant eccentricity of the center of mass and, as a consequence, unstable ballistic characteristics. To reduce the influence of this factor in the manufacture of such bullets in the industry, as a rule, injection molding is used.

One of the main ways to reduce the influence of the eccentricity of the center of mass of the bullet on the straightness of the trajectory is the unwinding of the bullet relative to the longitudinal axis as a result of interaction with the rifling of the barrel-stabilization by rotation (characteristic of rifled weapons) or the incoming flow of air or liquid-turning bullets (hunting smoothbore and smoothbore underwater hand-held firearms). At each revolution of the turning bullet there is a partial compensation of influence of eccentricity of the center of masses of a bullet which periodically appears directed in different parties from a longitudinal axis of a bullet. Turning bullets to hand-held small arms with a smooth bore in motion is provided by the presence of structural elements made at an angle to its longitudinal axis.

A significant influence on the ballistic properties of the bullet has the coefficient of aerodynamic force (coefficient of drag), directed along the longitudinal axis of the bullet, which depends in a complex way on the shape and speed of the bullet. Advantageous aerodynamic shape have a bullet with a conical, oval or hemispherical head; the least advantageous aerodynamic shape have a bullet with a flat head (typical for pistol bullets and some bullets to smoothbore hunting hand-held firearms).

Empirically found that the best ballistic properties have bullets with the largest mass at the smallest diameter. At the same time, bullets with a large elongation (swept bullets) have the greatest mass at the smallest diameter.

An important practical value is a significant increase in the coefficient of aerodynamic force at a bullet speed close to the speed of sound (about 340 m/s in the air under normal conditions). In this regard, in practice, the parameters of the bullet and the characteristics of the shot are selected in such a way that the bullet speed at the maximum firing range is higher or lower than the speed of sound (for hand-held small arms equipped with a sound suppression device).

Stabilization of the bullet is a prerequisite for the straightness of the trajectory of the bullet and high accuracy.

The ability of the bullet, considered as a body of rotation, to stabilize on the trajectory means the ability of the bullet to maintain the coincidence of the velocity vector with the longitudinal axis of the bullet under the influence of destabilizing factors. There are three main ways to stabilize the flight of a bullet on the trajectory: due to the shape of the bullet; due to the high-speed axisymmetric rotation of the bullet; due to the location of the center of pressure behind the center of mass of the bullet.

Stabilization due to the shape of the bullet is provided for bullets of stable ballistic shape. The stable ballistic shape of a bullet is a sphere. Using bullets of the spherical form is the most simple and effective way to stabilize the bullet trajectory. This effect has previously been used in muzzle-loading smoothbore handgun firearms, but due to the worldwide transition of the world's armies to rifled bore weapons, the use of such bullets is currently limited to use in smoothbore hunting handgun firearms. Bullets of this kind are prone to ricochets and are prohibited during collective hunts.

Stabilization of the bullet due to high speed axisymmetric rotation and the resulting gyroscopic effect is used in rifled weapons. In smoothbore weapons with this purpose may be used the barrel with the threaded end of the land or a special attachment with the rifling "paradox".

For shooting from a barrel with a rifled section or shooting with a nozzle "paradox" bullets of a special design are required that is caused by unfavorable conditions of interaction of a bullet body with rifling. In rifled weapons, the bullet begins to interact with rifling in the initial period of the shot, when the speed of the bullet is negligible, and acquires the necessary speed gradually, as the speed increases when moving along the barrel channel. When firing from a barrel with a rifled end section or when firing with a paradox nozzle, the bullet begins to interact with the rifling after reaching a high speed. In many cases, not intended for this bullet when interacting with rifling does not acquire the necessary axisymmetric rotation, and deformed and pushed through the rifled section of the barrel (there is a “breakdown with rifling”). The results of shooting such a deformed and unstabilized bullet significantly deteriorate.

In addition, it should be borne in mind that the frequency of axisymmetric rotation of the bullet, necessary for the occurrence of the gyroscopic effect, should be, depending on the caliber of several tens of thousands to several hundred thousand revolutions per minute. Such high rotational speeds cannot be achieved by unwinding the bullet by the incoming air flow in a smoothbore hunting hand held small arms firearm.

Stabilization bullets expense of location center pressure behind center masses bullets and emerging stabilizing moment aerodynamic forces relatively center masses is used in most bullets for hunting bullet patrons. A necessary condition for stabilization of the bullet is the location of the center of pressure of the bullet (the conditional point of application of the resultant aerodynamic forces acting on the bullet in flight) behind the center of mass. Stabilization bullets the specified way needs provide expense of design bullets by adherence to one any or simultaneously two conditions: center masses bullets should be shifted to parent parts of bullets; center pressure bullets should be shifted to tail parts of bullets.

The greater the distance between the center of mass and the center of pressure (shoulder stabilizing moment), the higher the efficiency of stabilization of the bullet. To shift the center of mass to the head of the bullet, the main part of bullets to smoothbore hunting hand-held firearms contains a heavy (for example, lead) head part and a light (for example, polymer) tail part. For maximum displacement of the center of pressure to the tail of the bullet can be equipped with a tail, which increases the stabilization due to the location of the center of pressure of the bullet behind the center of mass of the bullet.

The development of new types of designs of bullets used in the design of cartridges (ammunition), previously adopted, allowed to significantly change the properties of the complex “weapon — cartridge” as a whole, as well as to solve highly specialized problems. V. A. Ruchkin on this occasion notes that the constantly emerging need to solve narrow-purpose tasks inevitably leads to the specialization of small arms and ammunition used in it and, as a consequence, to the creation of fundamentally new models of small arms; it is possible to upgrade only ammunition with the same standard sample of weapons [228, p. 219–221].

The validity of this statement is clearly confirmed by the nomenclature of cartridges (ammunition) developed and used for shooting from a Makarov pistol (hereinafter-Mak) (figure 2.2.14).

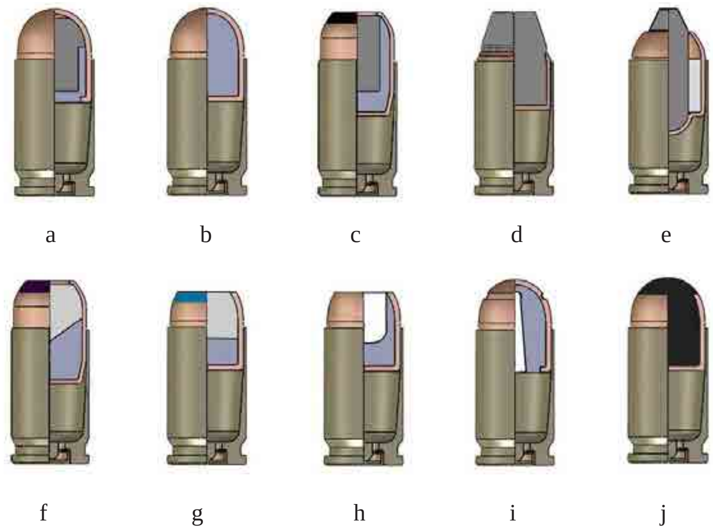


Figure 2.2.14 — **Pistol cartridges 9x18 Mak, used for shooting from a Makarov pistol:** a — 9-mm pistol cartridge (57-N-181S) with steel core bullet; b — 9-mm pistol cartridge (57-N-181) with lead core bullet; c — 9-mm pistol cartridge with bullet increased penetration action RG 028; d — 9-mm pistol cartridge with bullet increased penetration (7H15); e — 9-mm pistol cartridge (7N25) with armor-piercing bullet PBM; f — 9-mm pistol cartridge increased stopping action (SP-7); g — 9-mm pistol cartridge with bullet reduced penetration capacity (SP-8); h — 9-mm pistol cartridge with expansive bullet (PE); i — 9-mm pistol cartridge with a bullet ricochet reduced ability (PRS); j — 9-mm pistol cartridge with combined semi-shell rubber bullet of limited striking capacity

Bullets to rifled manual small arms firearms are divided into four main groups: single-element (bezobolochechnye); two-element (shell and semi-shell); three-element (shell); multi-element (special).

Single-element design have, in particular, bullets cartridges 5,6×16R, 5,6×10R, 7,62×39R, used for shooting sports and hunting rifled hand-held firearms. As a rule, they are made of lead and its alloys with antimony. However, lead does not provide a hard grip on the rifling of the barrel, which is the main drawback of such bullets. Under raising pressure gases in canal trunk is happening “disruption with rifling” that makes impossible the use of such patrons in combat manual small arms firearms in view restrictions primary speed and range called the shots. In addition, the use of lead complicates the action of automation of self-loading hand-held small firearms due to its partial evaporation and settling on the details of the exhaust mechanism.

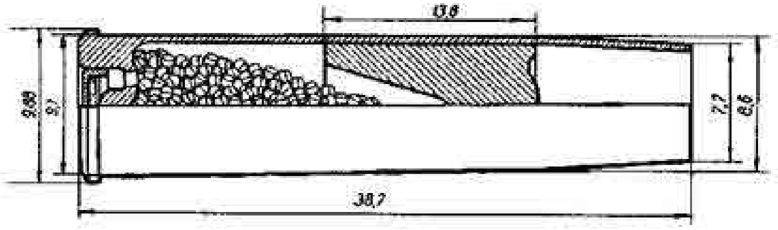


Figure 2.2.15 — **Device and dimensional characteristics of the 7.62×39R sports cartridge for the revolver “Nagan”**

The use of single-element bullets is currently limited because the lead used in their manufacture does not have the necessary characteristics. Exception comprise tselnotochenye bullets from copper alloys (bronze), designed to called the shots from sniper and hunting firearms (as rifled, so and smoothbore in as a subcaliber), the use of their in automatic weapons is limited to high labor intensity assemble and value of (figure 2.2.16).

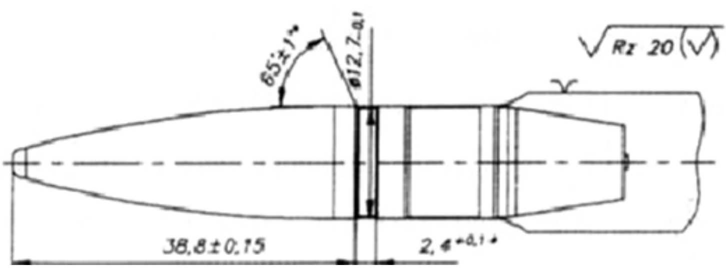


Figure 2.2.16 — **All-metal copper alloy bullet to sniper cartridge 12,7×114**

For shell (two-element) bullets, such a disadvantage as a breakdown from the rifling is not characteristic. In such bullets, the lead core is placed in a shell of brass, Nickel silver or bimetal, which ensures easy forcing of the bullet when entering the rifled part of the barrel bore in the initial period of the shot and the absence of failures with rifling.

Melchior (an alloy containing 80 % copper and 20 % Nickel) is considered to be the best material for making bullet shells for rifled hand-held small arms, but cheaper materials are currently used. For the manufacture of cartridges (ammunition) in the Russian Federation used bimetal-3 (steel 11KP, clad tompak L90). Tompak layer (alloy 90 % copper and 10 % zinc) covers the steel on both sides, its thickness is 4–6 % of the thickness of the steel [90].

Design of jacketed hollow-point bullets suggests the presence of an unclosed contour of the tip of the bullet shell. These bullets are expansive (deformable) bullets. At a meeting with the target due to deformation of the lead vertex, pressure is created, deforming the bullet in radial directions, significantly increasing its cross-section and, accordingly, the kinetic energy transmitted to the target. In addition, in order to enhance the damaging effect, the shell structure may have longitudinal external or internal incisions (figure 2.2.17).

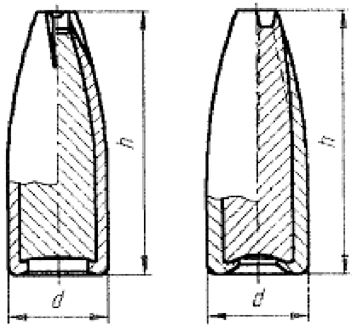


Figure 2.2.17 — **System expansive bullets with longitudinal cuts shell**

This type of bullets is used in hunting rifled hand-held firearms caliber 5.45–9.5 mm when hunting medium and large animals, as well as pistol cartridges (ammunition) used by law enforcement agencies. Their use in combat (military) hand-held small arms is prohibited by international treaties.

Expansive bullets are divided into three main types: with limited expansiveness; without limitation of expansiveness; fragmented.

Bullets with limited expansiveness consist of a tompak shell divided into two parts: a weakened head and a strengthened head. When the target is hit, the head part expands, transferring kinetic energy to the target, while the tail part provides a greater depth of penetration. Another option is possible, when the function of weakening the head part is performed by a cavity in the lead core (figure 2.2.18).

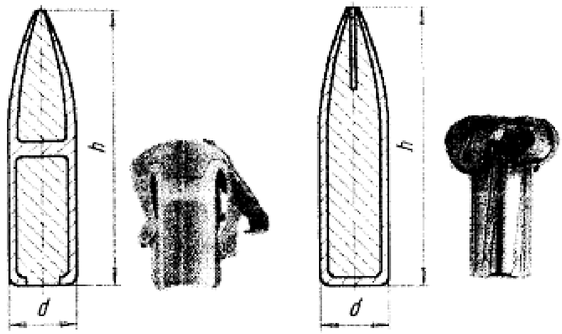


Figure 2.2.18 — **System expansive bullets with limited expansiveness**

Bullets without the limitation of expansiveness, as a rule, have a bare top in the head and a weakened shell structure in the form of longitudinal external or internal incisions (figure 2.2.17).

In fragmented (divided into separate fragments) bullets, in addition to the weakened shell structure, a core consisting of several sectors is usually provided, or cuts on the shell and cores to ensure the formation of separate striking elements at the time of hitting the target. For reliable action expansive bullets its kinetic energy at the time of destruction should be about 200 J.

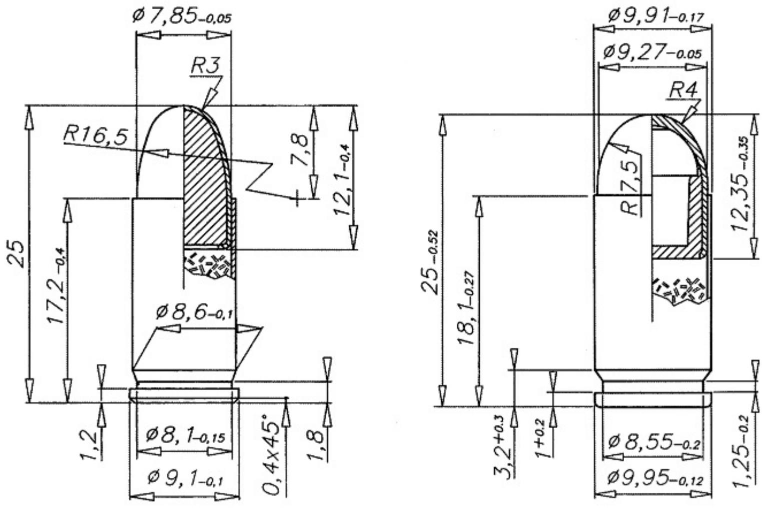
Pistol cartridges (ammunition) of 9×19 with expansive bullets possessing the increased striking action now received wide distribution. As examples of expansive bullets to smoothbore hunting manual small arms firearms can be called bullets Shirinsky-Shikhmatov, Polev-3, Polev-6, Hexolit32, as well as homemade explosive bullets inserted into the expansive cavity primer-igniter "Zhevelo" and a charge of gunpowder.

In modern cartridges (ammunition), two- (figure 2.2.19 a) and three-element bullets (figure 2.2.19 b) are used to combat rifled handheld small firearms. The use of three element bullets with steel cores in service and civilian weapons is prohibited by regulatory legal acts.

In bullets of three-element design the part of lead is replaced by a core from steel. This allows you to reduce the cost of production and provide a punchy action (previously, such bullets were called surrogate). In addition, increased action on the target can be provided by partial exposure of the hardened steel core protruding from the shell of the bullet. In General, such bullets consist of a core (steel, ceramic, polymer), a shell (element (part) of the bullet cartridge, designed to accommodate all its components and giving the bullet the necessary external shape) and a shirt (bullet element, which serves as a plastic base when cutting the bullet shell into the rifling of the barrel) (figure 2.2.14 e).

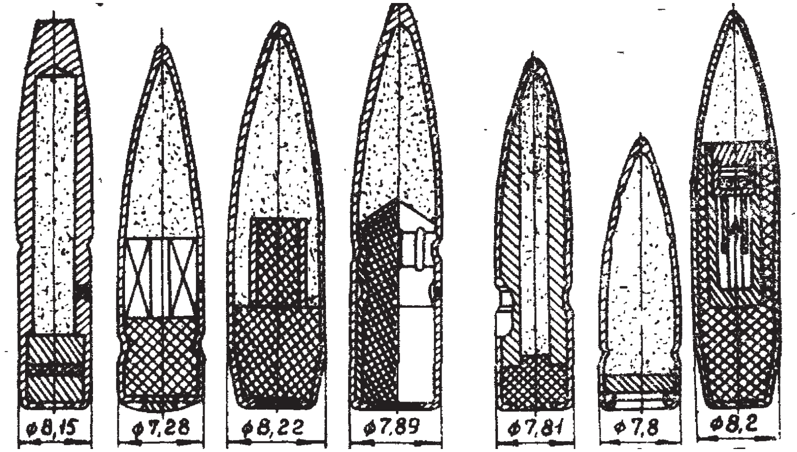
As a result of application of carbide cores of bullets of cartridges (9×18 Mak, 5,45×39) penetration of barriers and means of individual protection in comparison with bullets of usual cartridges (ammunition) improved.

Multi-element (special) bullets (tracer, incendiary, armor-piercing, incendiary, explosive, combined action) are used in combat (military) hand-held firearms (figures 2.2.20–2.2.24). The drawings depict bullets from the Second world war, but their elements are included in the design and modern bullets.



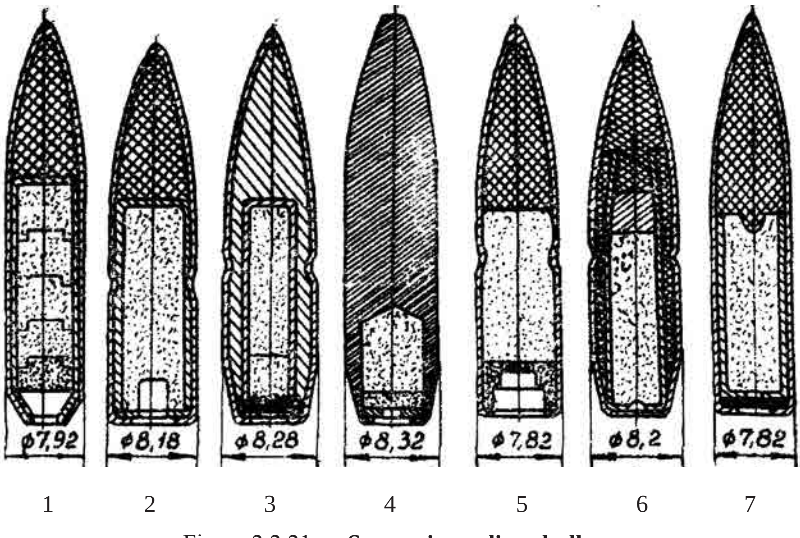
a b

Figure 2.2.19 — **System cartridge (ammunition):**
a — cartridge 7.65×17SR, equipped with a two-element shell bullet with a lead core; b — cartridge 9×18 Mak (57-N-181S), equipped with a shell three-element "surrogate" bullet with a steel core



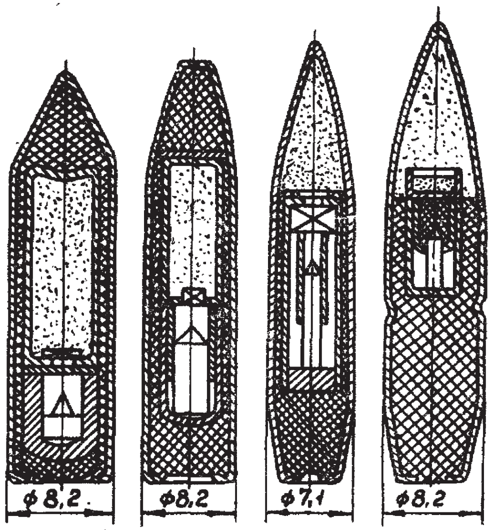
1 2 3 4 5 6 7

Figure 2.2.20 — **System tracer bullets:**
1 — T30 (USSR); 2 — England; 3 — Germany; 4 — France;
5 — USA; 6 — Czech; 7 — Finland



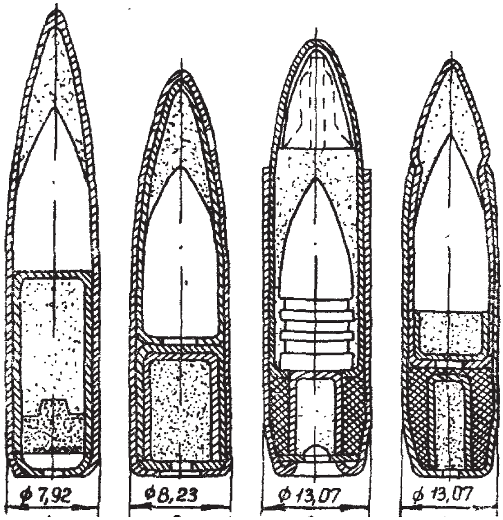
1 2 3 4 5 6 7

Figure 2.2.21 — **System incendiary bullets:**
1 — France; 2 — Spain; 3 — Poland; 4 — Japan; 5 — USA;
6 — France; 7 — Germany



1 2 3 4

Figure 2.2.22 — **System exploding bullets, slow-blow action:**
1 — Germany; 2 — Austria; 3 — Spain; 4 — Czech



1 2 3 4

Figure 2.2.23 — **System armor-piercing-incendiary-tracer bullet:**
1 — USSR; 2–4 — Italy

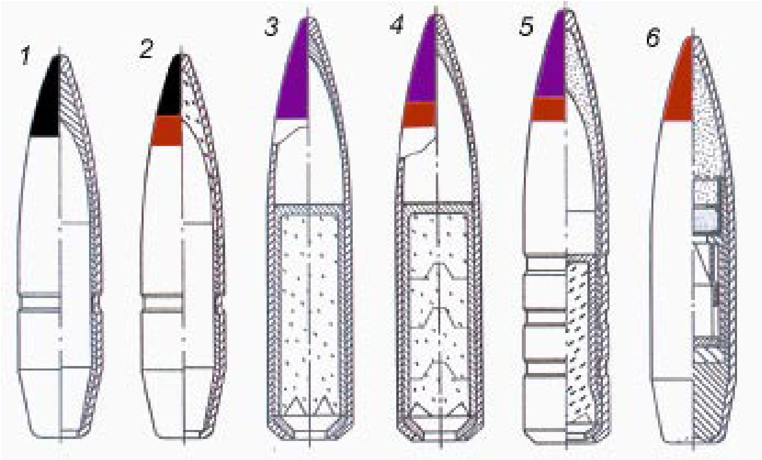


Figure 2.2.24 — **Special bullet cartridge 7,62×54R:**
1 — B-30 armor-piercing; 2 — armor-piercing incendiary (B-32);
3 — armor-piercing-tracer (BT); 4 — armor-piercing-incendiary-tracer (BZT);
5 — modernized (BZT; ZB-46); 6 — target-incendiary (ZP; PZ)

Development of cartridges (ammunition) with subsonic speed of the thrown element (“silent cartridges”) used in complexes of manual small arms with devices of silent and flameless firing (cartridges SP-5; SP-6; 12,7×55). Bullets data patrons (ammunition) provide sufficient zapregradnoe striking action on living goal on distances until 300 flushed (figures 2.2.25, 2.25.26).

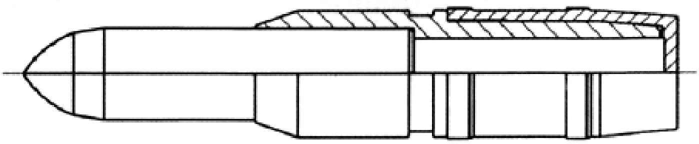


Figure 2.2.25 **— System multi-element bullets with tandem core cartridge (ammunition) 12.7×55 (SC-130 VPS)**

Bullet cartridge 12.7×55 (SC-130 VPS) has a tandem core. During a meeting with an obstacle, the armor-piercing core is embedded in it until it comes into contact with the shell, after which the shell stops. The cores come out of the shell, with the core located behind, transfers some of its kinetic energy to the armor-piercing, which breaks through the barrier.

Figure 2.2.26 — **Elements of a bullet with a tandem core of a cartridge (ammunition) 12,7×55 (SC-130 VPS) after defeat of the purpose**

Of particular interest is the projectile element of the cartridge (ammunition) used for firing from the automatic ADS (special two-medium machine). The design of the machine allows you to use it in two types of cartridges: cartridge 5.45×39 (7H6 and its modifications) and cartridge 5.45×39 PSP, corresponding to its dimensional characteristics (figure 2.2.27).

a b c

Figure 2.2.27 — **The bullet and the cartridge, the 5.45×39PSP:**
a — bullet cartridge 5,45×39PSP; b — cartridge 5.45=39PSP Assembly;
c — cartridge of 5.45×39 (7N6)

The use of the 5.45×39PSP cartridge of the new design of the throwing element provided the possibility of hitting targets not only in water but also in the air up to 400 m, which is practically comparable to the efficiency of the 5.45×39 cartridge (7H6) and distinguishes it from the previously used 5.66×39MPS cartridge with a needle-shaped throwing element, the effective range of hitting the target for which in the air was less than 50 m [198].

For shooting from modern sniper and rifled hunting firearms began to be widely used solid bullets made of copper alloys. It is noted in the literature that this improved the quality of their manufacture, minimized precessional and nutational oscillations of the bullet body on the trajectory and thereby significantly improved the accuracy of fire [44; 207, pp. 85–86].

As for cartridges (ammunition) for smoothbore firearms, the promising direction of improving the designs of the throwing element was the development of swept sub-caliber bullets with pallets of pulling, pushing and combined types made of polymeric materials [144].

Hunting bullet cartridges contain a cartridge case, a primer-igniter, a propellant charge and throwing equipment (a bullet or bullets). Depending on bullet design and method of manufacture the cartridges can contain a wad-seal the wad-seal with a damping element, the container, the container with a shock absorbing element, a composite container with two or more sectors and other auxiliary items.

A significant disadvantage of most hunting cartridges (ammunition), equipped with bullets of classical designs (“Sputnik”, brennecke, Mayer, etc.), is the lack of reliable obturation, which reduces the effectiveness of smoothbore hunting weapons in its operation. The use of polymer materials in the design of bullet pallets for such weapons allowed to normalize intra-ballistic processes when fired, reduce the muzzle pressure of powder gases and thereby improve the accuracy of fire and increase the speed of the bullet. This became possible due to the fact that in the process of firing the pallet, expanding in radial directions, improves the obturation, performing “forcing” functions by increasing the coefficient of friction between the mating surfaces, as a result ensuring the effectiveness of the propellant charge and the projectile element of the cartridge (ammunition) [288, pp. 34–37]. Typical for these types of throwing elements are field bullets of all modifications, bullet Sauvestre and other types of sub-caliber bullets.

For shooting from smoothbore hunting firearms, expansive bullets with an increased damaging effect (for example, hexolit32 bullet) are also used, in the construction of which obturating rings made of polymeric materials are also used (figure 2.2.28).

a b c

Figure 2.2.28 — **The bullets of the cartridges (ammunition) for smooth-bore hunting weapons:**

a — swept sub-caliber bullet Polev-6U with a three-element pallet pulling and pushing type; b — Sauvestre swept sub-caliber bullet with two-element pallet of pulling-pushing type; c — expansive bullet of the increased striking ability Hexolit32 (at defeat of the purpose)

Most commercially produced shotgun cartridges (ammunition) are equipped with a polymer wad-container with a shock-absorbing link.

Wad-container provides protection of the primer-igniter and propellant charge from the influence of environmental factors, obturation of gunpowder gases when fired, pressure relief of gunpowder gases in the initial period of the shot and protection of the bore from the impact of shot. In accordance with GOST 28653-90 “Small Arms. Terms and Definitions” wad-container is a part of a sports (hunting) cartridge for small arms, designed to accommodate a shotgun shell and for obturation of powder gases (figure 2.2.29) [190].

Figure 2.2.29 — **Polymer wad container for shot**

The necessary elements of the wad container is circular bands in the zone of the obturator in the bottom of the container, and in some constructions and in front of the petals container. Ring belts facilitate the installation of wad container in the sleeve. In addition, in the annular belt located in the area of the obturator, there should be one or two slots for air outlet when installing the wad container in the sleeve. In the absence of slots, air compression occurs in the space between the bottom of the wad container and the powder, preventing the installation of the wad container in the sleeve until it stops in the propellant charge. Air outlet slots do not have a significant effect on the obturation of powder gases when fired.

Elastic thin-walled petals wad container should be connected to each other with a thin jumper or jumpers, providing a stable shape of the petals. The rupture of thin jumpers connecting the petals of the container occurs during the shot or after the departure of the wad container from the barrel. Under the influence of the incoming air flow, the elastic thin-walled petals are bent. As a result of the increase in resistance, there is a rapid braking of the wad-container, necessary for the smooth flight of the sheaf of shot.

Deformation of the wad-container damping link is a necessary condition for pressure relief of powder gases in the initial period of the shot. The shock-absorbing link can be additionally provided with lateral protrusions limiting deformation. With a significant transverse deformation of the shock-absorbing link that occurs when the shot is fired, the side protrusions rest against the walls of the sleeve, limit the deformation and serve as a load stabilizer.

The above-described operational advantages of using polymeric materials in the construction of welded elements of ammunition (ammo), despite their dignity, from the point of view of judicial-ballistic examination of these objects significantly complicate the task of identify a particular instance of small firearms, from which they were fired.

In addition to bullets, shot and buckshot (shot >5.0 mm in diameter) can be used in smoothbore hand-held firearms. Lead for shot can be mixed with tin, arsenic, antimony and other substances, depending on the content of which the shot is divided into hard (hot) and soft. Lead shot of industrial production is covered with a thin layer of graphite. In clad shot the lead ball is coated with a layer of Nickel or Nickel silver.

Depending on the diameter of the fraction is divided into: *small* (No. 10 – No. 6, with a diameter of 1.75 mm to 2.75 mm); *medium*

(No. 5 – No. 1, diameter from 3 to 4 mm); *large* (No. 0, 2/0, 3/0 and 4/0, with a diameter from 4.25 to 5.00 mm).

To determine the number of fractions with uniform mass and shape characteristics, it is necessary to lay 10 pellets along the ruler and measure the total length of the formed series of pellets (in mm). After that determine the average diameter of the pellets in D_{mean} by the formula:

$$D_{mean} = \frac{L}{10},$$

where D_{mean} — is the average diameter of one pellet (mm), L — row length of 10 pellets (mm).

The obtained value is compared with the reference literature and the fraction number is determined.

Table 2.2.5 — **Table of numbering and notation of fractions in different countries**

Pellets diameter, mm	**Pellets number**				
	Russia, Germany	**USA, Canada**	**Sweden**	**England**	**Belgium**
5.00	0000 (4/0)	Т и О	11	AA	000
4.75	000 (3/0)	BBB	10	-	00
4.50	00 (2/0)	BB	9	BBBB	0
4.25	0	B	8	BBB	-
4.00	1	1	7	BB	1
3.75	2	2	6	B	2
3.65	-	-	-	1	3
3.50	3	3	5	2	-
3.25	4	4	4	3	4
3.00	5	5	3	4	5
2.85	-	-	-	$4^{1/2}$	6
2.80	-	6	-	5	-
2.75	6	-	2	$5^{1/2}$	-
2.50	7	7	1	$6^{1/2}$	7
2.40	-	$7^{1/2}$	-	7	-
2.25	8	8	0	8	-
2.00	9	9	00	9	8
1.75	10	10	-	10	9
1.70	-	-	-	11	10
1.50	11	11	-	12	11
1.25	12	12	-	dust	12
1.00	-	dust	-	-	-

The throwing element of hunting shotgun cartridges (ammunition) is an unordered collection of balls of lead pellets. For various types of hunting, cartridges equipped with lead pellets of different diameters can be used. Such cartridges (ammunition) contain a sleeve, a primer-igniter, a propellant charge, a throwing equipment (lead shot) and (or) a wad-container or a wad-obturator with a shock-absorbing link. The fraction withheld from precipitation in the cartridge rolling body shells, multi-beam star or strip by a circular rolling or pouring edge strip with a mixture of wax and paraffin in ratio of 1:1 (with makeshift equipment in a metal shell).

In the forensic study of hunting shotgun cartridges (ammunition) should take into account the high dynamic loads affecting the shot when fired. Axial loads on the fraction increase in the direction from the cut of the body to the bottom of the sleeve. Thus, the greatest load when pellets experiencing layers of shot adjacent to the bottom of the wad container or wad obturator. With excessive loads on the shot at the shot possible deformation of the pellets.

Load fraction and the likelihood of deformation of the fraction increases with increasing mass fraction, the increase of the length of the cartridge, reducing the height of the shock absorbing element of the wad container or wad of skirt, to increase the initial velocity of the fraction and pressure of the powder gases. Deformation of the pellets is typical for 12/76 caliber cartridges with an increased mass of the shot. For 12/89 caliber cartridges, the shot loads can reach such high values that the pellets are pressed into the bottom of the container and the pellets stick together in the layers experiencing the greatest loads.

Axial loads acting on the fraction when fired, also lead to the appearance of radial forces in the fraction. Radial forces pressing the outer layer of the pellets to the walls of the sleeve cause the braking of the pellets. Braking forces, in turn, depend on the number of pellets of pellets. For a small fraction with a large number of balls, the braking force is significantly higher than for a large fraction with a small number of pellets. Thus, the increase in diameter of the fraction, ceteris paribus leads to a reduction of inhibition of the fraction at a pellets, and this in turn — reduce pressure of the powder gases and increase the initial velocity of the fraction.

Cartridges (ammunition), equipped with steel shot, in the territory of the former USSR did not receive wide distribution. One of the drawbacks of cartridges (ammunition) of this type is the possibility of damaging the barrel of the gun as the result of exposure to steel pellets. The GOST R 50530 limits the diameter of the steel pellets, as well as the initial velocity and momentum when fired. In addition, in accordance with the requirements of the steel pellets must be completely in the container, protecting the bore from the impact of steel pellets. However, with homemade equipment, steel balls from rolling bearings can be used as pellets [200].

The main operational characteristics of hunting cartridges (ammunition), equipped with steel pellets, are its mass and initial speed.

The low density of steel compared to the density of lead causes a low mass of steel shot in the cartridge. Other things being equal, the weight of steel pellets is about 70 % of the weight of lead pellets. With the same diameter of steel and lead shot balls the ballistic characteristics of steel shot balls are significantly worse than the corresponding characteristics of lead shot balls and the speed of steel shot balls decreases faster on the trajectory. At the same time the low weight of the steel shot allows for a higher initial speed of the shot.

Hunting buckshot cartridges (ammunition) contain a sleeve, primer-igniter, propellant charge, propellant equipment (lead buckshot), powder gasket and gasket (cover) placed on top of the propellant. In addition, cartridges (ammunition) of industrial manufacture, equipped with buckshot, may contain a wad container or a wad obturator with a shock-absorbing link.

Unlike shot cartridges (ammunition) containing an unordered set of shot balls, buckshot cartridges (ammunition) under normal equipment contain an ordered set of buckshot balls. Buckshot balls should be placed in the cartridge in an orderly, parallel rows, containing from 2 to 5 balls. The diameter of the buckshot balls is selected taking into account the minimum gap between the balls in a row. Thus, there is a stable pattern between the inner diameter of the sleeve, the diameter of the buckshot balls and the number of buckshot balls in a row.

The arrangement of the rows of buckshot balls of the second and each subsequent row can be of two variants: above the corresponding balls of buckshot of the previous row; in the recesses between the balls of buckshot of the previous row.

In accordance with the current terminology buckshot is a large diameter shot. For equipment of hunting buckshot cartridges the buckshot KO (buckshot hunting) according to GOST 7837 is used.: 5.25; 5.60; 5.70; 5.80; 5.90; 6.20; 6.50; 6.80; 6.95; 7.15; 7.55; 7.70; 8.00; 8.50; 8.80; 9.65; 10.00 mm. For equipment of hunting buckshot cartridges, as a rule, auxiliary elements of the equipment intended for hunting shotgun cartridges are used (wads-containers of industrial production, self-made containers made of polymeric materials; matches, straws, wooden splinters placed vertically between the rows of buckshot; buckshot (shot) is poured with talc or potato starch to prevent crumpling when fired).

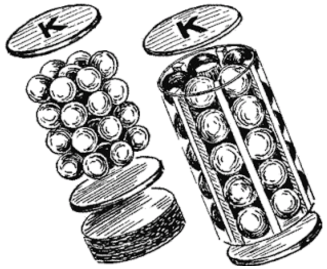


Figure 2.2.30 — **Placement of buckshot in the cartridge (ammunition) for smoothbore hunting hand-held firearms**

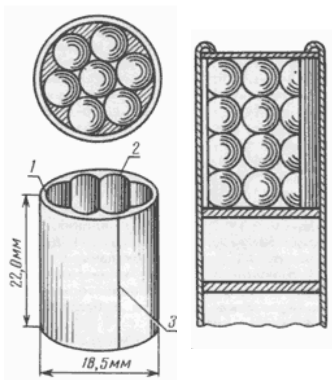


Figure 2.2.31 — **Polymer container for buckshot**

Axial loads acting on the buckshot when fired, lead to the emergence of radial forces in the buckshot. Radial forces press the buckshot balls against the walls of the sleeve and create braking forces. The number of buckshot balls is small, so the braking forces are negligible compared to shotgun cartridges (ammunition). Slight braking of buckshot leads to a significant decrease in the pressure of the powder gases and creates conditions for a significant increase in the initial velocity of the thrown element. When the weight of buckshot, slightly different from the mass of the shot, its initial velocity can be higher than the initial velocity of the shot at 30–50 m/s.

In forensic practice, there is a so-called associated buckshot, when buckshot in self-loaded cartridges (ammunition) are connected to each other by a metal wire or a strong thread “triangle” or “star” to improve the accuracy of fire.

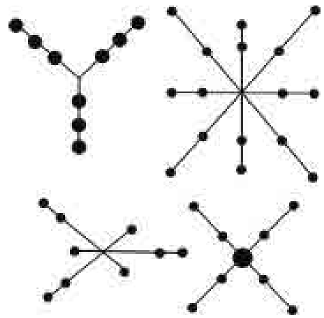


Figure 2.2.32 — **Methods of binding buckshot**

Proceeding from the stated, at production it is judicial-ballistic examinations of cartridges (ammunition) in research part of the conclusion the following characteristics of object of research shall be reflected:

for the cartridge as a whole:

– construction (state of visible structural elements);

– General weight and size characteristics (total length, weight);

for bullets:

– type (shell, semi-shell, non-shell), type (ordinary, special), as well as the shape of the head (pointed, oval, hemispherical, flat);

– dimensional characteristics (diameter of the leading part);

– sheath material;

– method of fastening in the sleeve (core, rolling, segment crimp, tight fit, etc.);

– color marking (if available);

– location relative to the cut of the sleeve body (protrudes, is below (above) the cut, recessed into the sleeve body — if necessary);

for shells:

– shape (cylindrical, bottle, conical);

– type (fully or partially protruding flange, flanged, with ledge);

– length;

– diameter at a cut (diameter of a muzzle in sleeves of the bottle form);

– diameter of bottom part (flange);

– the presence of a capsule (initiation device);

– type of capsule;

– the presence of traces of puncture of the capsule;

– the presence of flutes and other design features (if available);

for cartridges equipped with multiple throwing element (projectile) must be installed:

– a method of sealing (rolling) the shell casing and fixing the projectile (circular rolling, "multibeam star", gasket, etc.);

– markings (if any).

In addition, it is necessary to establish the individual characteristics of the object of study (the outer surface of the structural elements) in order to determine: the method of manufacture; defects; the presence of traces indicating a possible homemade equipment or re-ammunition factory production.

Thus, the following conclusions can be drawn from this section:

1. Improving the design of cartridges (ammunition) used for shooting small firearms, is through the development of new and modernization of existing elements of the design of cartridges (ammunition) with the aim of obtaining the necessary characteristics of action at a target in the shooting, raising vneshnepoliticheskikh characteristics, the possibility of breaking the existing and future personal body armor, due to the decision of specific tasks and manual small firearms (combat, service, civil), in which cartridges (ammunition) are used for firing.

2. The design of some cartridges (ammunition) does not contain a propellant charge (gunpowder) as an energy source, its functions are performed by an increased linkage of the pyrotechnic composition of the primer-igniter. At the same time, the energy characteristics of the striking ability of the thrown element (bullet) remain at a sufficient level to defeat the target. Consequently, the absence of a propellant charge in the design of such cartridges is not a basis for excluding them from the category of ammunition. The determining criterion for assigning such a cartridge to the category of ammunition should be sufficient to defeat the target value of the kinetic energy of the thrown element.

3. The widespread use of polymer materials in the design of the sleeve and the projectile element of cartridges (ammunition) significantly complicates their expert study in solving identification problems in the framework of forensic ballistic examination of these objects and the establishment of a specific instance of the weapon from which the bullet or sleeve was fired. One of the possible ways to solve this problem is the application of forensic marks on the parts of hand-held small arms, interacting with the elements of the cartridge design (ammunition) in the production of loading, firing, extraction and ejection, but this issue requires a separate scientific study.

4. Promising areas of improvement of the design (and its individual elements) of the cartridge (ammunition), the possibility of using some of their types for shooting in different environments (in air and liquid environments, mixed conditions), airspeed (subsonic and supersonic) are taken into account in the development of the author's classification, given in section 2.1 of Chapter 2 of the work.